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EVERYTHING PNEUMATIC.

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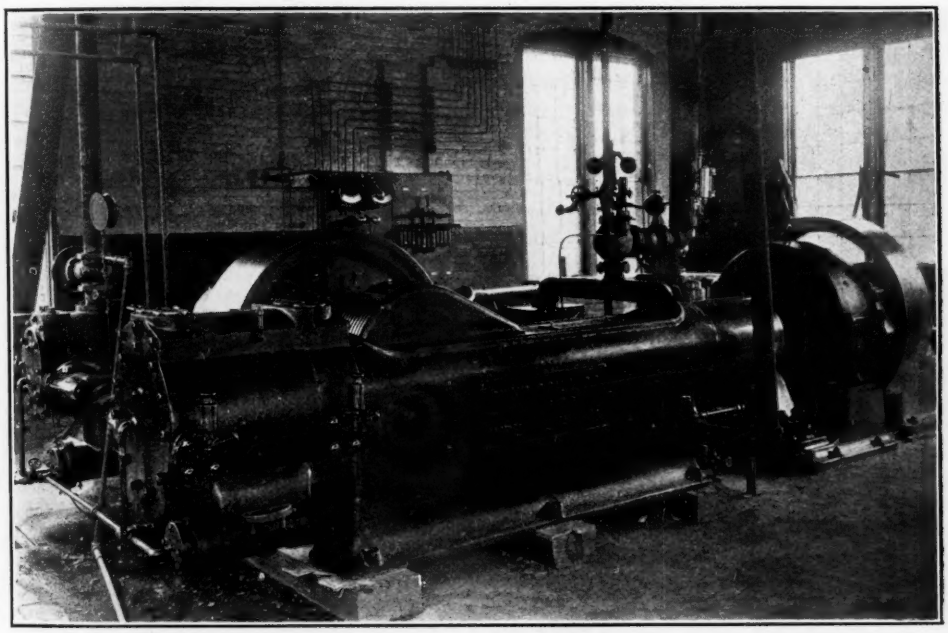


AIR COMPRESSOR WITH EXCELLENT RECORD.

A REMARKABLE AIR COMPRESSOR RECORD

BY FRANK RICHARDS

The half-tone on this page reproduces an excellent photo of an air compressor at the Hollenbeck Colliery of the Lehigh & Wilkesbarre Coal Company with a record worth noting. This, as will be seen, is an entirely self-contained machine with high pressure steam cylinders and two-stage air cylinders, the diameter of the former being 12 in. and the latter 18 in. and 11 in., with a common stroke of 16 in., the theoretical free air capacity at 150 r.p.m. being 704 cu. ft. per min. This compressor was shipped on June 27, 1905, and was immediately installed and put to work. Since then it has been operated continuously 24 hours per day, with the exception of a regular stoppage of two hours on Sundays for inspecting the discharge valves and a general cleaning up and looking over. For three or four years past the machine has been too small for the work and has been run at a speed from 170 to 225 r.p.m.—600 ft. piston speed. We have the word of the engineer of the power house that none of the cylinders have been rebored, that the compressor is still fitted with the same pistons and piston

rings that it had when shipped from the factory. Discharge valves and discharge valve springs have been occasionally renewed, but some of them ran five or six years. There has never been any delay at this colliery that could be attributed to the compressor.

This machine has recently been replaced by a compressor of much larger capacity. When the change was to be made they picked it off its home foundations and placed it on the power house floor upon three 12 by 6 in. timbers as shown, without bolting down or fastening of any kind, made the pipe connections and started it up at once, and it is still running at its highest speed. The photo shows the compressor running, as is indicated by the disappearance of the fly wheel arms. The governor is evidently not running, as the chain which drives it is not in place. The sharpness of every detail in the photo shows the entire absence of jar or vibration.

The record of this machine is a record also for those who have had it in charge. It has had the best of care and systematic inspection. The oil, for instance, has been taken out of the crank cases and filtered every three weeks with such renewal as might be necessary. Beyond such care as this the engineers have had the happy faculty, sometimes painfully lacking, of letting well enough alone and giving things a fair chance. Records either good or bad could often have been reversed under different managements.—*Power.*

WHAT WAR DID FOR SUGAR

A hundred years ago in the days of the great Napoleon, sugar had already become more than a luxury and was much sought. As England controlled the seas and controlled also the sugar industry of the West Indies, Napoleon Bonaparte conceived the idea of developing the beet sugar industry so that France might be made independent of the rest of the world so far as its sugar supply was concerned. Our sugar books are full of the history of the gradual development of the beet sugar industry, the extraction of the beet juice by the old roller mills and later by hydraulic presses, and we might say only recently by diffusion, and this great industry producing now nearly half the sugar of the world, was the child of the Napoleonic wars that sprung direct from the brain of Napoleon Bonaparte when he was at the zenith of his powers.

A NEW DUST CATCHING LIQUID

In the F pit of the Washington Coal Co., southeast of Newcastle-on-Tyne, there was given recently a commercial scale trial of the new Belger colloid dust-laying process.

About 400 yd. of a main haulageway, along which pass 1,000 tons of coal a day, had been sprayed with the Belger fluid during the previous two months. The fluid, whose main components are glue and a 40 per cent. solution of calcium chloride, is sprayed from a 100-gal. tank, devised by A. Owen Jones.

This tank can come down the shaft in the cage and is then placed on wheels. The air used is at a pressure of about 2 atmospheres. It enters the tank by several small openings, so as to churn the fluid into foam, and a small jet of air is led into the outflow pipe to help the treacly liquid to become spray. The nozzles are of rubber, to enable solid particles to pass.

Humorists said the Belger process meant making the miners walk on flypaper, and any looker-on whose hand was accidentally sprayed found himself collecting every speck of dust which came near him for the rest of the day. But the track where the process has been used feels like a peaty path in dry weather, being slightly springy and not at all sticky.

Outside the sprayed area the track is several inches deep in fine dust. The sprayed roof and walls are sticky and look for a week or two as if whitewashed, then the gathering dust blackens them, but it does not appear that a fresh spraying will be needed for three months. The liquid is used warm, at 50 deg. C. to lessen its surface tension, but the spraying is not followed by evaporation, so no falls of roof result. Indeed, the liquid preserves rock from erosion and timber from decay, and does not, like water, encourage ankylostomiasis and other low forms of life.

The cost of using this spray in coal mines is about 50c. per yard per year.

Lately wood has been made fire proof by forcing into the same a solution of salt under high pressure, whereby its appearance and other properties were not changed. Such wood in contact with fire melts the impregnated salts and forms a crust, keeping the air off. By further increased heat the salt is decomposed, furnishing vapors which extinguish the flames

SAFETY AIR CUSHIONS FOR WOOLWORTH . . . BUILDING ELEVATORS*

Recent tests of the automatic safety cushions in the bottoms of the shafts of the very high passenger elevators in the Woolworth Building, New York City, have demonstrated a high degree of efficiency in smoothly, quickly and safely stopping the cars when falling freely from their maximum height of about 600 ft. The application of the air-cushion system involved the construction of heavy airtight walls inclosing the bottom of the elevator shafts for several stories and capable of resisting a high, sudden internal pressure. There are also provided strong airtight entrance doors in different stories and special outlet valves to release the air and maintain the desired pressure under the piston action of the air. Inlet valves eliminate suction from ascending cars.

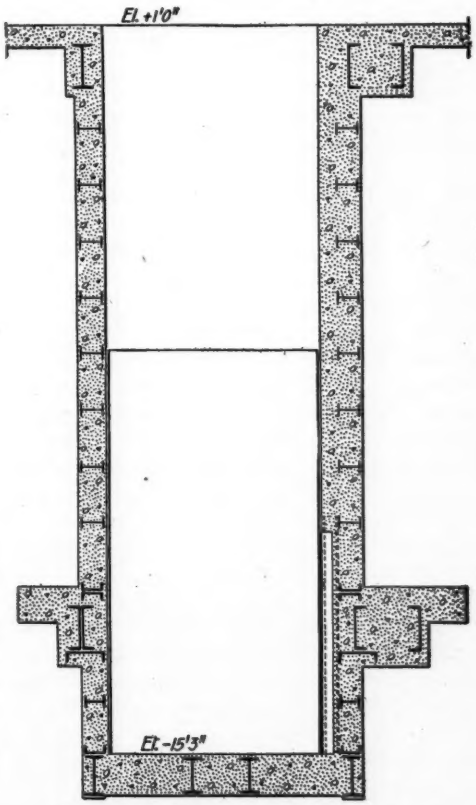
ELEVATOR EQUIPMENT.

The Woolworth Building has one of the largest and highest sets of passenger elevators ever installed. There are twenty-six electrically operated cars designed for a combined capacity of about 6000 passengers per hour in each direction carried at a speed of 600 ft. per minute for the low rises and 700 ft. per minute for the high rises. They are of the Otis standard gearless type, such as are used in the Metropolitan Life Insurance tower, Singer tower and other high buildings, and have cars of from 30 to 50 sq. ft. floor area which are provided with the usual safety appliances for stopping them in case of accident or excessive speed. Two cars travel 679 ft. from the first to the fifty-first story, two travel about 606 ft. from the first to tthe forty-sixth story, two travel 530½ ft. from the basement to the fortieth story, fourteen travel 358½ ft. from basement to the twenty-seventh story, two travel to the twenty-eighth story and four travel to the twelfth story.

AIR CUSHIONS.

To provide a safeguard against injury by too rapid descent each elevator has the lower portion of its shaft inclosed in air-tight steel and concrete walls, adapted to retain the air under the plunger action of the descending car and form an elastic cushion, bringing it gradually to rest. The cushion walls extend up to the fourth, fifth, seventh, eighth and eleventh stories, according to the height of the elevator shaft, and have a maximum effective height to 135 ft. 3½ in. The walls are of concrete reinforced with horizontal web I-beams, except in cases where the counterweight walls are too close to the car shaft to admit the concrete construction. Steel buckle plates are used to cover the counterweight shaft.

In all cases the faces of the walls are parallel, except at the bottom, where for a distance of about one story they are narrowed to fit the car quite closely. The webs of the I-beams on all four sides of the shaft are in the same horizontal plane and are cut to clear; they are spliced together at the corners by top and bottom web cover plates. They are connected to the structural columns by hitch angles and have grouting holes through the web. The lower 18 ft. of the walls are "cladded" with Portland cement and hardwood, the elevator platform with trimming pieces being used as a template allowing from ¼ in. to ½ in. clearance.

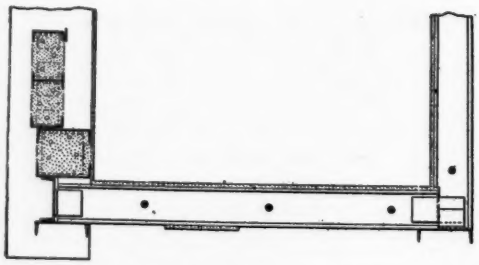


SHAFT TO RESIST CUSHION PRESSURE

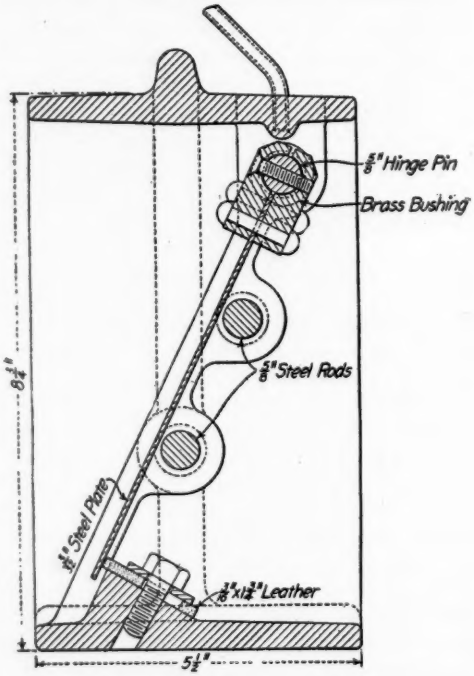
*Engineering Record, Sept. 5, 1914.

The calculated average pressure required was less than 15 lb., but it was assumed that in service an instantaneous pressure slightly exceeding 20 lb. per square inch might be developed in the air cushion, and the walls were proportioned to withstand a pressure of 15 lb. with a maximum fiber stress of 20,000 lb. per square inch, the possible theoretical excess of the pressure not being computed to exceed the elastic limit. Under test the actual maximum pressure at the bottom of the cushion was about 18 lb. To resist these pressures, the lower doors are made of flattened drawn-steel tubes having an elastic limit of 44,000 lb., with tongues at the bottom, which are held in steel sills firmly built into the floor concrete. The upper doors, which could be thicker than the lower ones on account of space conditions, are made of similar oval steel tubes plated back and front with Nairno ½-in. wire-glass panels in the center. The doors are operated by the Burdett-Rowntree compressed-air apparatus, by which they are automatically closed and maintained closed when not held open by the operator, a condition which is essential to the integrity of the system.

In the lowest 15 ft. of the air cushion the clearance between the car and the wall is one-thirty-fifth the area of the car; above that point it is one-fifteenth the area of the car. The natural efflux of air between the car and the sides of the shaft is therefore constant for nearly the full height of the cushion, and without regulation would result in an intensification of pressure at the bottom of the shaft and in violent changes of velocity. To regulate these conditions the air in the cushion is controlled by special outlet valves set in the walls at different heights and adjusted to open instantaneously under a pressure of 12 lb. per square inch, or slightly less than the calculated pressure to allow for their inertia. They are disposed vertically in the shafts, so that as the falling car passes it cuts off their areas consecutively. Thus the car itself reduces the area of efflux so as to render retardation theoretically nearly uniform. There are in all 126 outlet valves, each having an area of 0.4 sq. ft. As no standard valves could be obtained which were sufficiently free from inertia to be satisfactory for this purpose, special valves were designed by Thomas E. Brown to secure positive, accurate, and rapid action. They consist of sheets of 1/32-in. tempered spring steel about 5 in. wide. The upper edge is securely clamped to a hinged bar and the reinforced lower edge is normally confined between adjustable stops on both sides. Under the required pressure the deflection of the thin plate displaces the lower edge sufficiently to clear the stops, and the valve swings open.



SHAFT FRAMING FOR AIR CUSHION



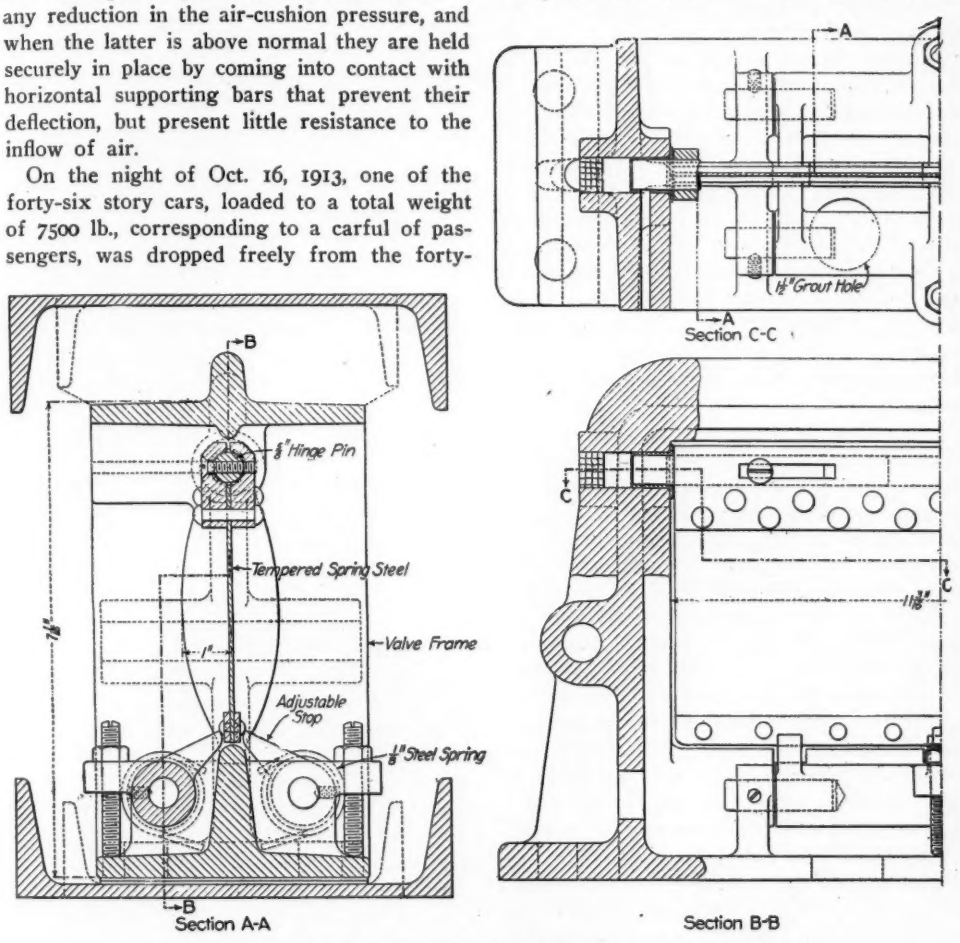
INLET VALVE FOR AIR CUSHION

INLET VALVES

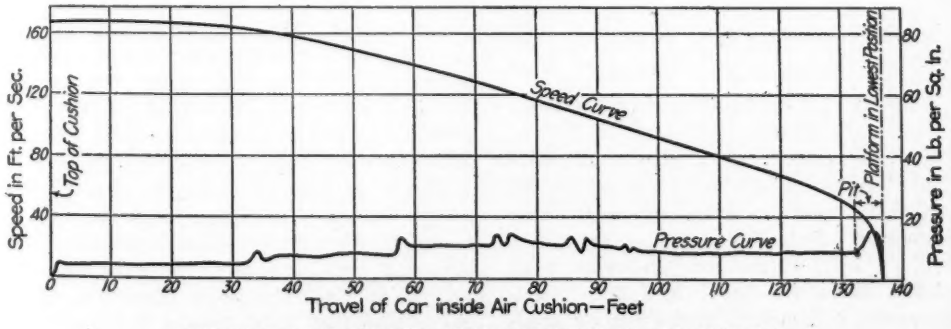
In order to prevent retardation of the cars in normal service when lifted out of the cushions seventy-two inlet valves about 12 in. long and 6 in. wide are set in the lower part of the walls. They are simple check valves made

of inclined steel plates hinged on the upper edge and bearing on the lower edge against leather stops. They are opened by the exterior atmospheric pressure whenever there is any reduction in the air-cushion pressure, and when the latter is above normal they are held securely in place by coming into contact with horizontal supporting bars that prevent their deflection, but present little resistance to the inflow of air.

On the night of Oct. 16, 1913, one of the forty-six story cars, loaded to a total weight of 7500 lb., corresponding to a carful of passengers, was dropped freely from the forty-fifth floor and stopped safely by the action of the air cushion. It fell 470 ft. to the top of the air cushion in 5½ sec., and came to rest safely at the bottom of the air cushion in



OUTLET VALVE FOR RELIEVING PRESSURE IN AIR CUSHION



DIAGRAMS OF VELOCITIES AND PRESSURES IN AIR CUSHION

about 1½ sec. more. The cushion worked satisfactorily and the car doors and walls showed no indication of injury. The velocity in the cushion part of the shaft was reduced regularly and uniformly, and the pressure developed in the body of the cushion did not exceed 15 lb. per square inch, except at the last moment at the bottom of the pit, when it was increased to a maximum of 18 lb.

TESTING APPARATUS

The testing apparatus consisted of six specially designed steam-engine indicators with large drums equipped with electric magnets to hold the pencil points off the drums until the magnet current was broken. All the drums were rotated at constant speed by electric motors. Four indicators were connected with the shaft by pipes—one at the bottom and the three others at nearly equal intervals up to the fifth floor.

Two indicators were placed in the car. One was connected to the interior pressure by a pipe through the bottom of the car and the other to a water column carried in the car, consisting of a brass tube about 7 ft. high, to register the intensity of retardation. The motor revolving the drums of the two indicators in the car was equipped with a flywheel heavy enough to maintain constant speed during the short time of the fall, as current was cut off from this motor by the pulling out of a plug the instant the car left its starting point at the forty-fifth story. The magnet current of the fixed indicators was carried by a wire stretched across the top of the air-cushion shaft, which was broken by the car at the instant it entered the cushion.

The cushions and auxiliaries were designed by Thomas E. Brown, consulting engineer of the Otis Elevator Company, who planned and directed the test. Cass Gilbert was the architect of the building, and the Thompson-Starrett Company was the general contractor and installed the air cushions and valves.

AN AIR LIFT FOR AN EMERGENCY

BY M. J. MC GILL.

We hung 34 ft. of 6-in. pipe in the shaft from a point one set below the station and blanked the lower end except for a 1-in. drain with a gate valve. Within 4 in. of the end of some 2-in. pipe, we drilled several ¾-in. holes, and just above this tapped in a ¼-in. nipple with an ell on each end. In the outside nipple we screwed a ¼-in. pipe. The ¼-in. and the 2-in. pipes bound together, we lowered into the 6-in. pipe. The ¼-in. was connected to the compressed-air line, compressor pressure being 100 lb.; the 2-in. pipe was connected to an old 2-in. air line, which led to the winze. At about 100 ft. in we put in a tee on the 2-in. line and a valve to relieve the air pockets. The flow of water was directed into the 6-in. pipe. With the air-inlet valve open about one-sixth of a turn, the water kept about 14 in. below the top of the 6-in. pipe, except when the miners turned on the air to blow smoke from the shaft bottom.

POWER OF WINDMILLS

The following table, compiled by the Electric Review, shows the horse power which can theoretically be realized from a 28 ft. wheel exposed to winds of various velocities:

Speed of wind, m.p.h	H.P.	Speed of wind, m.p.h.	H.P.
2.25	0.04	22.5	40
6.7	1.1	33.5	135
11.2	5.0	45.0	520
15.7	13.0	67.0	1,080

The power available should increase with the cube of the wind velocity (since the kinetic energy of the air particles increases with the square of their velocity and the number of them striking the wheel blades per second increases in direct proportion to the wind velocity). It is not practicable to construct a mill which will use with equal efficiency a light breeze and a strong wind, hence the curvature and setting of the blades should be such that the mill works most efficiently when exposed to a wind of the velocity generally prevailing in the district. Breezes of eight to 15 m.p.h. are much more common than 20 m.p.h., hence it is generally advisable to employ a very light wheel which will start work in a 3.5 m.p.h. wind, and which can still be used when the wind rises to 10 m.p.h. Such a wheel could not be exposed fully to a 30 m.p.h. wind, and for safety a device should be mounted on the main wheel so that when the wind pressure exceeds a certain limit the inclination of the blades is changed, against the control of a spring, in such a manner as to reduce the effective area exposed to the wind. The control springs may conveniently be set so that they come into operation when the wind velocity exceeds 16 m.p.h., and so that the output of the mill is constant in winds above 18 m.p.h; there is thus secured maximum total annual output.

ENERGY OF A HAMMER DRILL BLOW*

The Paynter rock drill tester, a remarkably ingenious and useful machine, by means of which a graphic record of a drill's hitting ability is obtained, has been developed and put into service at North Star Mine, Grass Valley, California. The machine registers the intensity of the blow of the drill and makes it possible to count the strokes. Some interesting conclusions have resulted from a series of experiments conducted with this machine.

To express the energy of the blow in foot-pounds, the tester was calibrated by allowing a sphere of known weight, suspended as a pendulum, to fall through measured distances against the plunger of the tester. The corresponding distentions of the diaphragm, which controls the movements of the recording pencil, were noted. By forcing oil into the system with a pump, the diaphragm was distended to each of these points in turn, and the static pressure corresponding to each was read on the gage. A curve was then constructed with foot-pounds as abscissas and pounds of static pressure as ordinates. The strength of any blow, recorded on the graph, can be measured by pumping oil into the system until the distention of the diaphragm moves the recording pencil out the corresponding distance. The pressure in the system at this point is read on the gage. The foot-pounds corresponding to this can then be taken directly from the curve. Since the areas of the plunger and of the diaphragm do not change, equal blows will produce the same pressure, even though permanent straining of the diaphragm may result in their producing unequal distentions. Errors which might be caused by these inequalities of distention are avoided by thus expressing strength of blow in terms of equivalent static pressure instead of magnitude of distention.

From the graphs taken by testing a drill at different gage pressures, characteristic curves may be constructed, as shown in Figs. 1 and 2. There are also given the results of tests made to determine, if possible, the relations existing between drilling speed, blows per minute and foot-pounds per blow.

Table I compares: *a*, Three drills striking a hard blow; *b*, two drills striking a medium blow. These were tested in extremely hard ground with holes at an inclination of 25°, 1¼-in. cross steel with 2¼- and 2-in. bits being used; conditions, however, were kept the same for each test, which lasted 5 min.

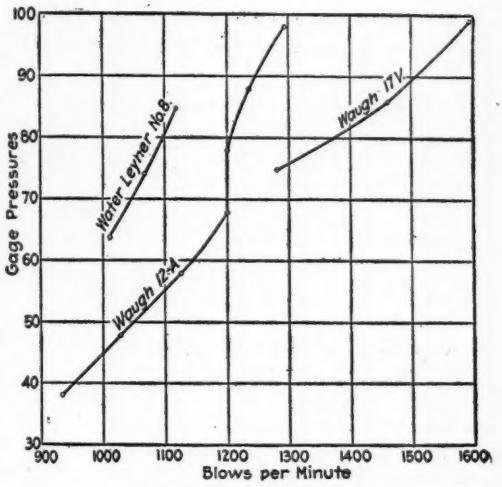


FIG. 1. CHARACTERISTIC CURVES OF TYPICAL MACHINES SHOWING INFLUENCE OF GAGE PRESSURE ON BLOWS PER MINUTE.

TABLE I—COMPARISON OF DRILLING SPEEDS.

	Foot-Pounds.	Blows per Minute.	Drilling Speed. Feet per Minute.
a	52	936	0.126
	52	1320	0.165
	55	1584	0.250
b	40	1260	0.108
	42	2352	0.195

These results indicate that drilling speed varies approximately with the blows per minute, the strength of the blow remaining constant.

Table II compares drilling speed with varying strengths of blow. The conditions of test were: Ground only medium hard; length of each test 5 min.; 1¼-in. cross steel with 2-in. bit; holes at an inclination of 45°; drill, air-feed stoper.

TABLE II—CHANGES IN STRENGTH OF BLOW.

Blows per Minute.	Foot-Pounds per Blow.	Feet Drilled per Minute.
1272	48½	0.378
1222	43	0.447
1200	38½	0.308
1170	34½	0.250
1090	30½	0.188

A test under the same conditions as that of

*From a paper by Robert H. Bedford and William Hague, Salt Lake Meeting of the A. I. M. E.

Table II, except that the inclination of the holes was 20°, gave the results shown in Table III.

TABLE III—RESULTS WITH FLAT HOLE.

Blows per Minute.	Foot-Pounds per Blow.	Feet Drilled per Minute.
1272	48½	0.251
1222	43	0.206
1200	38½	0.198
1170	34½	0.135

A test was made under the following conditions: Ground hard; length of each test, 5 min.; drill, No. 8 water Leyner; 1⅛-in. hollow steel with 2¼-in. bit; holes nearly horizontal. In this test varying strengths of blow were obtained by means of stops of different lengths screwed into the ends of the valve chest. The results are shown in Table IV. Test *a* was first made and the results confirmed with test *b*.

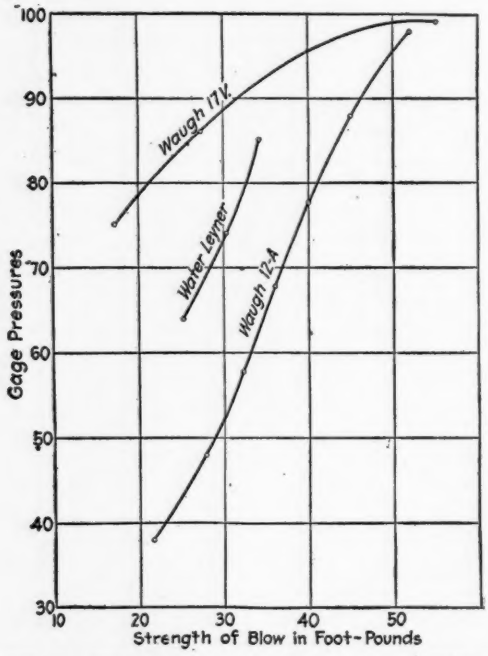


FIG. 2. EFFECT OF GAGE PRESSURE ON STRENGTH OF BLOW.

TABLE IV—LEYNER TESTS.

	Blows per Minute.	Foot-Pounds per Blow.	Feet Drilled per Minute.
a	1368	40	0.162
	1272	45	0.234
	1260	52	0.119
	1212	65	0.129
b	1368	40	0.135
	1272	45	0.224
	1260	52	0.183
	1212	65	0.195

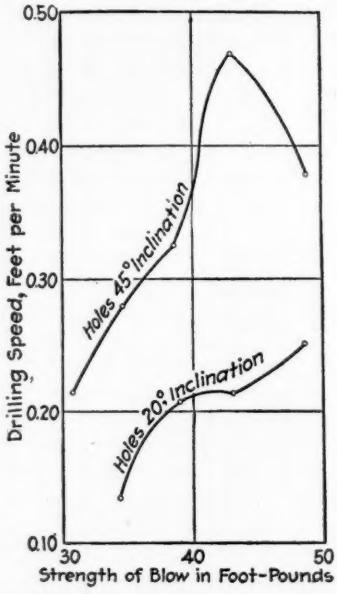


FIG. 3. INFLUENCE OF STRENGTH OF BLOW ON DRILLING SPEED OF AIR FEED STOPER.

As already stated, Table I indicates that for blows of equal strength the drilling speed is approximately proportional to the number of blows, even when these differ as much as 40 per cent. In constructing the curves of Figs. 3 and 4 from Tables II, III and IV, where the maximum variation in the number of blows is 15 per cent., the drilling speed has been arbitrarily adjusted according to the results obtained from Table I, so that the effects of the strengths of blow may be comparable.

These curves all show the same tendency to flatten at above a certain strength of blow, which in this ground happens to be about 45 ft.-lb. It will be noticed that the curves for the Leyner and for the stoper at 45° inclination are almost exactly similar. This is thought due to the fact that in each case the face of the hole is clear of cuttings. In the cases of the flat holes, which do not clear themselves, the drilling speed is not only lower, but does not show the same peak. This suggests that where holes can be cleared of cuttings a 45-ft.-lb. blow is sufficient to obtain the fastest drilling,

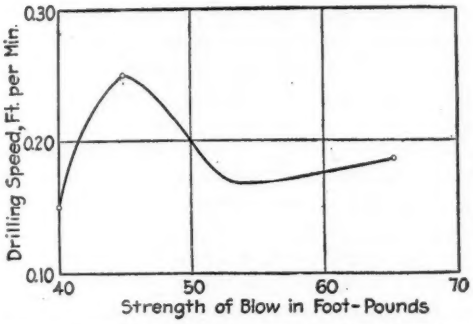


FIG. 4. INFLUENCE OF STRENGTH OF BLOW ON SPEED OF WATER LEYNER NO. 8.

whereas, in holes where the deadening effect of cuttings exists, the limit of effective blow is higher. This also emphasizes the desirability of a stoper with water feed to the face of the hole.

From these tests, and others giving similar results, it has been decided that for conditions existing at this mine, stoping drills should strike a minimum of 40 ft.-lb. As none of these drills has yet been found that strikes over 55, it remains solely a question of maintenance to keep them at this point.

The Leyner, with blows as high as 65 ft.-lb., presents a different problem. In this type the valve was so adjusted by means of standard plugs screwed into the ends of the valve chest, as to give at average gage pressure, blows in the neighborhood of 45 ft.-lb. It is hoped that this reduction in strength of blow will result in lessened breakage of steel, decreased repair costs, and maximum drilling speed. The adjustment has not been in use long enough to give any figures on the first two points.

The effect of setting the minimum strength of blow in the stoping drills at 40 ft.-lb. has been to increase the breakage of steel by 1 lb. per drill-shift, and the cost of repairs by 27c. per drill-shift. The footage drilled, however, has been increased 15 per cent., reducing the cost per foot of hole drilled from 20.3 to 18½c. The output per drill shift has increased 10 per cent. during the same period, but this figure is completed by the width of stope broken, and is therefore not quite comparable.

Examination of Table II shows the decrease in drilling speed that may be expected with a stoper striking 30 ft.-lb., as compared

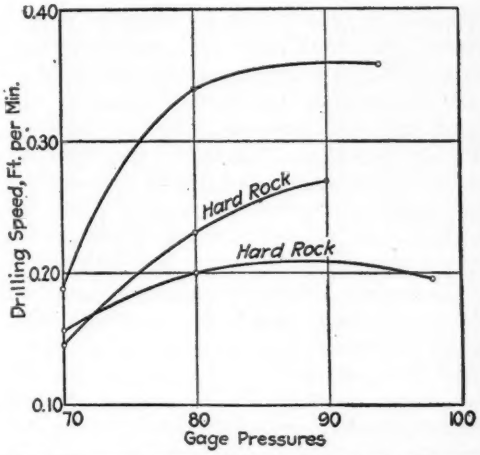


FIG. 5. INFLUENCE OF GAGE PRESSURE ON DRILLING SPEED.

with 45 ft.-lb. Of this point it may be stated that many confirmatory tests have been made. Unless the drills are maintained at their best, the strength of blow drops rapidly (sometimes after 100 drill-shifts), with resulting decrease in drilling speed. The cost per drill-shift, however, remains practically the same. It is obvious what the result will be.

MINERS IN HISTORY

BY HERBERT C. HOOVER.*

Coming now to authentic history, I may recall to you that Themistocles and Thucydides were miners, and I need but mention the Battle of Salamis to emphasize the miner's contribution to the preservation of civilization. Here the Asiatic was turned back from his attempt to subdue the West, when his success must have engulfed the civilization of Greece. It was the miners of Laurium who furnished the funds which built the Athenian fleet; it was a miner who directed the battle, and miners helped in the fight.

If type of metaphor stamps the calling of men, then we can claim Homer, Jeremiah and Virgil. Vulcan's workshop was described by no amateur, and as to the Golden Fleece, is it not an epic of the labors of many of our brothers? Jeremiah uses over a score of

*Extract from address upon receiving the medal of the Mining and Metallurgical Society of America.

technical metaphors, and his generally pessimistic and peevish mind further confirms the hypothesis that he was a metallurgist by calling. At one place he says; "They are all brass and iron, they are corruptors, the bellows are burned and the lead is consumed in the fire. The founder melteth in vain, reprobate silver shall men call them." Here is anguish over metallurgic failure which could be epitomized only by one of the calling.

To mention a few other figures of history, Philip of Macedon was a miner and founded his family and fortune on mines. The Athenian Nicias, the son of Nireratus, was a well known mine operator, but his attitude toward fellow professionals leaves something to be desired, for it is recorded that he bought a mine overseer for a talent of silver. While this price—equivalent to $40,000 in modern purchasing value—showed an early appreciation of proper fees, yet the buying of him lacked the delicacy of approach to professional engagements that we should have liked to find. There was also Diphilos, an engineer who was beheaded by Lycurgus for directing the robbing of mine pillars. I trust, in calling attention to this precedent, I shall cause no embarrassment to my Pennsylvania friends.

Demosthenes was on the borderland of our profession—he was a mining lawyer. Some of his earliest recorded orations before the Athenian Senate were delivered as counsel in mining cases. Theophrastus, who succeeded Aristotle as head of the Peripatetics, was a mineralogist. Theophrastus was the first author to assert that minerals propagate themselves and grow, and therefore he was the founder of the school of secondary enrichment.

Hannibal was a mining engineer and the son of a miner. Our confidence, however, in his technical abilities is a little dampened when we hear it asserted that in his long uphill fight against the Romans, he used vinegar to quench his fire-breaking of the Alpine roads. The frightened Romans, however, who record this, may have had the same illusions as to his engineering abilities that the news writers have of some of our modern colleagues.

There is also a *Praefectus Metallorum* who, in time of rebellion or strike of his miners, confined them underground and traded them food and water for ore. I have felt that he may have perhaps been worried out of the usual humane paths of our profession by the demands of some Roman Federation of Miners.

I need not repeat to you that after Roman times an almost complete eclipse occurred in all civilization and industry. Only after the lapse of centuries of historic darkness does the European world find itself, at the break of dawn, completely enthralled by the superstition of the Church and by the arms of the Feudal System. The masses were enslaved to the soil; the skilled workers were held rigorously to their hearthstones by primogeniture in calling; and the learned professions, except theology of the orthodox order, were held as heretical or dangerous to the state.

It is at this stage of the world's history that the miner performed what is to me the most impressive service that any calling has done for humanity, for it was the miners who rekindled the light of liberty which ended this darkest period of human history. Long before the awakening of learning, and long before the time of Agricola, the miners of Northern Europe had broken down the universal tyranny of feudalism. Earlier than the 10th century they had demanded and had been granted the free government of their own communities and industry; they had established their own officials and courts. The free mining cities of Saxony and Bohemia, the self-governing communities of Cornwall, Devon, the Forests of Dean and Mendip, and the High Peak of Derbyshire had blazed the way to representative government long before Mother of Parliaments sat at Westminster. They even led the way for the free merchant cities of the Baltic and England, and soon after the arrival of the Normans, we find in English history references to the "miner's right" to their "ancient liberties" and "customs," terms resonant of independence.

This fine spirit of independence seems to me to be a concomitant of the miner's calling, for not only do we discover it in all those times, but the life of our mining camps of the last ten decades is replete with it. None but men of intelligence and courage can serve in its ranks. Its daily work and daily experience are pregnant with enterprise and adventure. There is yet another characteristic of the

miner which, while not so evident in these days, yet stands out vividly enough in the past. The daily invasion into the unknown earth, the dead darkness in which his lamps serve to distort every shape, the uncanny noises of strained rocks, the approach of danger and death without warning, the sudden vanishing and sudden appearance of good fortune, have colored the miner's mind with distinct mysticism, and fallowed the field for religious fervor. But, not less, have all these experiences developed in his character courage, idealism, and self-sacrifice.

It was this spirit of mysticism, of courage, of independence, this free thinking and free governing in the free mining communities of Saxony which gave birth to the soul of Martin Luther. It was the miners of Saxony who rocked the cradle of the Reformation and it was the miners like Fabricius, and sons of miners, who formed the band who supported his life work. In this connection, I should not fail to mention an engineer nearer to our own times—Swedenborg. Of the same type of character was Georgius Agricola. Agricola was not a narrow slave of his profession. He was a man of deeply religious and courageous nature, the first citizen of his city, the distinguished servant of the state.

Aside from his great inventory of the professional stores of learning in *De Re Metallica,* we should all know that in the history of science and thought, it was Agricola who laid the first stone in the foundation of the modern structure of science. His long overlooked *De Ortu et Causis* is not only the first work on geology and ore deposits, but was the first production of science built upon deductions from observed natural phenomena. It was the first break from the dry scholasticism of the Middle Ages.

I will not dilate on *De Re Metallica,* for the book itself is its own recommendation. That it had an untold influence on the mining world is amply evidenced by the fact that it passed at least ten editions in three languages, and maintained its position as the text book of the profession for nearly two centuries. Nothing could bear higher testimony to its esteem and usefulness than that it was chained in iron bindings in the town halls, for miners to consult at will.

To me, one of the most interesting of Agricola's themes is his vigorous support of his profession. Despite the note of liberty first sounded by the miners of Europe, or perhaps because of it, the miners were not free from constant criticism and assault from the clergy and the scholastic classes, nor is our profession still free from occasional necessity to defend its right to esteem. It is now nearly four centuries since Agricola wrote: "Inasmuch as the chief callings are those of moneylender, the soldier, the merchant, the farmer, and the miner, I say, inasmuch as usury is odious while the spoil cruelly captured from the possessions of the people innocent of wrong is wicked in the sight of God and man, and inasmuch as the calling of the miners excels in honor and dignity that of the merchant trading for lucre, while it is not less noble, though far more profitable, than agriculture, who can fail to realize that mining is a calling of peculiar dignity?"

POCKETS OF DEAD AIR TOO MUCH FOR AN ORGAN BLOWING FAN

The matter of arranging ducts which convey air for one purpose or another is very often carried out without the slightest thought of keeping the system as a whole free from places in which air can become stagnant, and which, as a consequence, can prevent air from flowing past that particular point and set up a pressure which acts against the fan or other blowing apparatus. This fault is also met with in surface condensers in which spaces that are not swept out by the steam exist. Such spaces become filled with air, which is packed up into them under a slight pressure, and which is simply alternately compressed and re-expanded, and not removed, thus occupying valuable condensing space and, at times, making the condenser of little use.

The case which the writer has in mind is that which happened to a church organ in a small town in the Midlands. The writer visited the remarkably fine parish church in order to admire its architecture. Whilst looking round the chancel, a young fellow, who was trying to get the organ to play, asked the writer if he understood organs, as this particular one would not act owing to the impossibility of getting sufficient wind from the blowing engine. The writer, though not an organist, happens to be enough of a musician to feel sympathy for anyone in such a plight, and also

being an engineer and, therefore, blessed with the "let's-see-what's-up-with-it" temperament, offered to look into the matter and see what could be done.

On going behind the organ the request was made to have the air ducts from the organ to the fan pointed out; these were followed up, and there were at least three places in which air could lodge and form a lock. The fan was situated in a basement and was driven by a small gas engine. What baffled the organist, who was a pupil come into practice, was that the church organist, who was his instructor, had come in with him and started up the engine, and then gone to keep an appointment in the town; the engine was running all right, and everything appeared in correct order, yet no wind could be obtained to keep the organ playing; a few feeble notes and then a dead stop was all that could be done. Suspecting an air lock, the writer told the musician to go up to the organ and to continue to play the instrument until he was asked to stop, whether the notes spoke or not. This was done, and, of course, tended to draw all air from the ducts as soon as the pressure in the air lock dropped and let the air pass to the pipes; to accomplish this, the engine was shut down, and left down for about five minutes. At the end of that time the engine and fan were again put into service, when, to the surprise of the musician and two friends who were with him, the organ shortly began to play in its usual style. In return, the writer was favored with one or two selections, and could not help smiling at the wonderment of the musician and his friends; "Why," they asked, "should stopping the engine and starting it up again settle matters?" and it was not possible to make them really see the effect of an air lock.

What had caused the trouble in this case was that the ducts had in them sufficient air in one of the bends to nearly fill that bend; when the fan was started up this air became compressed to a slight extent, and just gave enough back pressure to prevent the fan sending any air forward, the fan, of course, being fairly well loaded up with the work of churning the air which surrounded it. The bends in this case were square and at right angles, and there was a bad dip.—*Power User.*

GRAPHIC AIR COMPRESSION COMPUTATION

BY F. H. ROSENCRANTS.

In connection with compressed air work a common problem is the determination of the power necessary to compress a given volume of air from one pressure (usually that of the atmosphere) to some other higher pressure. It can be shown mathematically that the power absorbed in the cylinder by the air is:

$$hp. = \frac{144\,P_1\,V_1}{33{,}000} \times \frac{n}{n-1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

in which

P_1 = Absolute intake pressure in lb. per sq in.;

P_2 = Absolute discharge pressure in lb. per sq. in.;

V_1 = Volume of free air compressed per min. in cu. ft.;

n = Factor varying in air compressors from 1.25 to 1.35, depending on the efficiency of cooling by the jacket. A common value of this factor is 1.30.

This formula is long and tedious to apply, especially if one is not familiar with the use of logarithms and calculating devices. It is for the purpose of solving this formula graphically that Fig. 1 was designed. The heavy broken line X indicates how the chart is to be used, but possibly a brief explanation will make it clearer. The data for the problem solved is as follows:

Volume to be compressed per minute (V_1) = 24 cu. ft.; initial absolute pressure (P_1) = 14.7 lb.; discharge absolute pressure (P_2) = 114.7 lb.

Solution: Starting with the volume of 24 cu. ft. at the top of the chart drop vertically down to the diagonal line representing the intake pressure of 14.7 lb. From there follow to the right to a point between the two diagonal lines labeled 7 and 8 respectively, or to be exact to a point representing 7.8, the value of the ratio

$$P_2 \div P_1 = 114.7 \div 14.7 = 7.8$$

Then drop vertically to the answer of 4.1 hp. at the bottom of the chart. If a mechanical efficiency of 85 per cent. is assumed the indicated horsepower of the driving engine is

$$4.1 \div 0.85 = 4.82$$

It will be evident that a problem with the same data as above, except that V_1 be 240 cu.

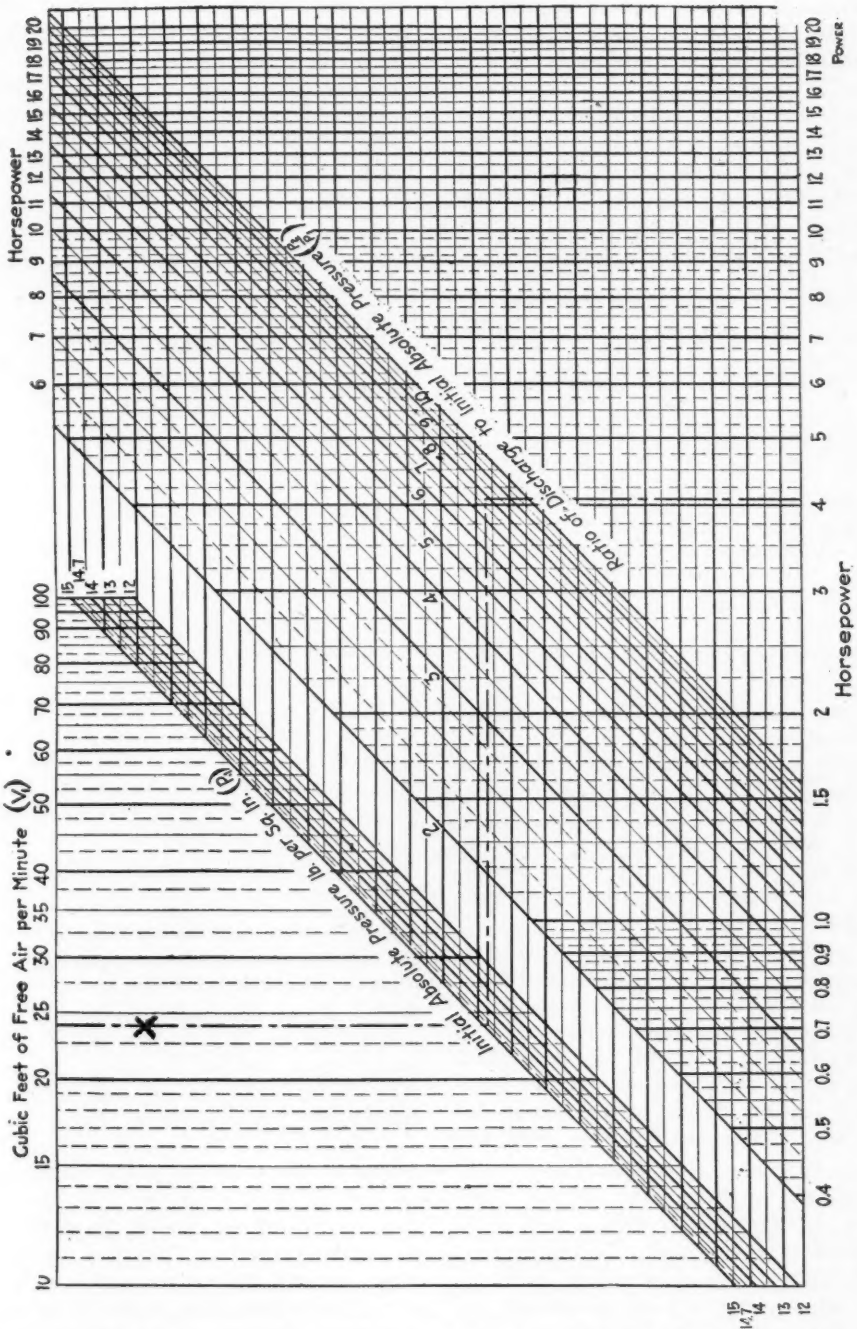

Horsepower
Power
Cubic Feet of Free Air per Minute (V)
Initial Absolute Pressure lb per Sq. In. (p1)
Ratio of Discharge to Initial Absolute Pressure (p2/p1)
Horsepower

FIG. I. CHART FOR DETERMINING HORSEPOWER REQUIRED TO COMPRESS GIVEN VOLUME OF AIR FROM ONE PRESSURE TO A HIGHER PRESSURE.

ft. per min., would be solved by using the same line and that the answer would be 41 hp., the difference in the solution being in the placing of the decimal point. The range in volume of air on the chart being from 10 to 100 cu. ft. per min. makes the range unlimited by merely shifting the decimal point on the volume scale and making the corresponding change on the horsepower scale.

The value of the factor n for which the chart was plotted is 1.30. This figure was chosen because it is the value most commonly used. In Table 1 are given factors by which

TABLE 1. FACTORS BY WHICH TO MULTIPLY RESULTS WHEN n HAS VALUE OTHER THAN 1.3

	Values of $P_2 \div P_1$								
n	2	3	4	5	6	7	8	9	10
1.20	0.976	0.962	0.953	0.946	0.941	0.936	0.932	0.927	0.927
1.25	0.988	0.982	0.977	0.974	0.971	0.969	0.966	0.963	0.962
1.35	1.008	1.017	1.020	1.024	1.028	1.031	1.033	1.036	1.038
1.40	1.016	1.029	1.039	1.048	1.055	1.059	1.063	1.067	1.071

to multiply the results when n has a value other than 1.30. To illustrate its use assume that n in the above problem has a value of 1.40, the value for adiabatic compression of air. The proper factor by which to multiply will be found in the bottom line of the table 0.8 of the way between 1.059 and 1.063, which is equal to 1.062. Therefore, multiplying the chart answer of 4.1 hp. by 1.062 gives 4.35 hp., the desired result.

The use of the chart is not necessarily limited to air problems, since by using the proper value of n it is applicable to any gas. In general the value of n is slightly less than the ratio of the specific heat at constant pressure to that at constant volume of the gas in question.

While the chart is primarily designed to solve problems for single-stage compression, it may be used also to determine the necessary power for two-stage compression. It can be shown that for the most economical results in two-stage compression the intermediate pressure should be equal to the square root of the product of the intake and discharge pressures; i. e., equal to $\sqrt{P_1P_2}$. It may also be shown that for this intermediate pressure the work done in each of the two cylinders is the same. Therefore, having determined the intermediate pressure, which will be called P', the horsepower absorbed in each of the two cylinders is:

$$hp. = \frac{144\,P_1\,V_1}{33{,}000} \times \frac{n}{n-1}\left[\left(\frac{P'}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

the same formula which the chart was designed to solve. Therefore, having obtained the result of this solution from the chart the total horsepower absorbed in both cylinders is obtained by multiplying by two. To illustrate, assume the same data as for the above problem except that the compression is to be two stage.

Solution: The intermediate pressure is

$$P' = \sqrt{P_2P_1} = \sqrt{114.7 \times 14.7} = 41.06\ lb.$$

Then the ratio of compression $P' \div P_1$ in the low-pressure cylinder is

$$41.06 \div 14.7 = 2.79$$

For 24 cu. ft. of air per min. and this ratio of compression, the chart gives a value of 1.80 hp. Therefore, the total horsepower absorbed in both cylinders is

$$2 \times 1.80 = 3.60$$

Assuming a mechanical efficiency of 85 per cent., the indicated horsepower of the driving engine is

$$3.60 \div 0.85 = 4.23$$

Fig. 2 becomes useful when it is desired to determine the necessary piston displacement of a compressor to deliver a definite volume of free air under given conditions of intake and discharge pressure. Also in calculating the probable amount of air that a compressor of given dimensions will deliver under given conditions of intake and discharge pressure and speed.

Referring to Fig. 3, representing the indicator diagram of an air compressor, it is evident that when the piston reaches the end of the compression stroke, corresponding to the point A, the clearance volume C will be full of air at discharge pressure. This air will expand as the piston starts back on the intake stroke and no air will be drawn into the cylinder until the pressure therein has fallen to the intake pressure. Hence the volume of air drawn in at each stroke will be somewhat less than the piston displacement, the amount being dependent upon the clearance volume and the ratio of the discharge to the intake pressure. The ratio of the air drawn into the cylinder per stroke to the volume of the piston displacement is called the volumetric efficiency of the compressor. In Fig. 3 this ratio is approximately $DF \div DE$. Mathematically expressed the volumetric efficiency is:

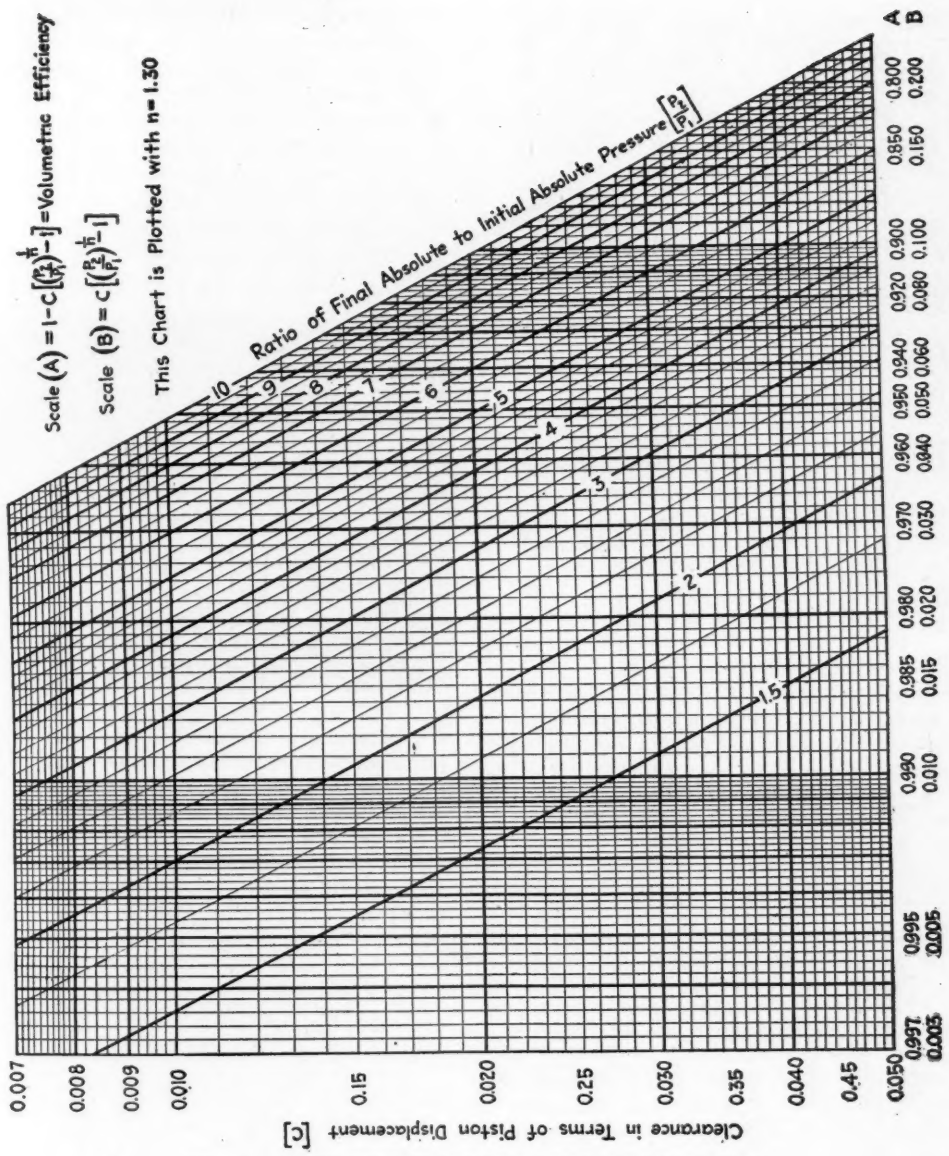


FIG. 2. CHART FOR DETERMINING VOLUMETRIC EFFICIENCY.

$$1 - C\left[\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right]$$

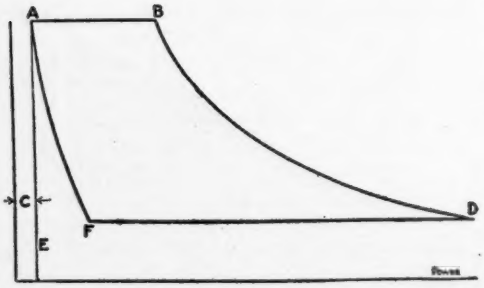
in which C is the clearance volume in terms of the piston displacement and the rest of the notation has the same meaning as in the previous formula.

Fig. 2 is for the purpose of solving this formula. The method of using it is self-evident, but to make it perfectly clear the following example will be solved.

Given: Clearance volume $C = 0.02$ of piston displacement; $P_1 = 14.7$ lbs. abs.; $P_2 = 75$ lb. abs.

Required: The volumetric efficiency.

Solution: Starting on the left-hand side of the diagram at 0.020 go in a horizontal direc-



tion to a point between the two diagonal lines labeled 5 and 6 respectively, or to be exact to a point representing the value of

$$P_2 \div P_1 = 75 \div 14.7 = 5.1$$

From there drop vertically to the answer on scale *A*, which for this case is 0.950.

To make the diagram applicable to problems in which *n* has a value other than 1.30 the scale *B* has been placed on the diagram. This is equal to 1 — scale *A*, or to

$$C\left[\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right]$$

To solve problems similar to the above when *n* has a value other than 1.30 proceed in exactly the same manner except that the result is read on scale *B*. Then multiply this by the proper factor from Table 2 and subtract the result from 1, giving the desired volumetric efficiency.

TABLE 2. FACTORS BY WHICH TO MULTIPLY SCALE B IN FIG. 2 WHEN n HAS A VALUE OTHER THAN 1.30

	Values of the Ratio $P_2 \div P_1$									
n	1.5	2	3	4	5	6	7	8	9	10
1.20	1.097	1.112	1.132	1.150	1.162	1.169	1.178	1.187	1.192	1.196
1.25	1.041	1.064	1.070	1.077	1.080	1.082	1.088	1.091	1.093	1.095
1.35	0.959	0.950	0.941	0.936	0.932	0.929	0.927	0.926	0.924	0.922
1.40	0.918	0.907	0.892	0.886	0.880	0.872	0.866	0.864	0.860	0.857

As a last example involving the use of both charts, take the following problem: A single-stage compressor is desired which will compress 2000 cu. ft. of free air per min. from a pressure of 14.7 lb. abs. to a pressure of 70 lb. abs. What should be the piston displacement per minute, and what should be the indicated horsepower of the engine, assuming a mechanical efficiency of 85 per cent.

Solution: From Fig. 1 the power absorbed in the cylinder by the air is 238 hp. Then

$$238 \div 0.85 = 280$$

as the indicated horsepower of the driving engine.

From Fig. 2 the volumetric efficiency is found to be (assuming a clearance of 2 per cent.) 0.954. Dividing 2000 by 0.954 gives 2096 cu. ft.

To allow for leakage past the piston back through the discharge valves, for effect of rise in temperature during the suction stroke, etc., this quantity should be increased by from 3 to 8 per cent. Therefore, assuming the loss due to these causes to be 5 per cent., the required piston displacement becomes

$$1.05 \times 2096 = 2200.8 \text{ } \textit{cu. ft. per min.}$$

—*Power.*

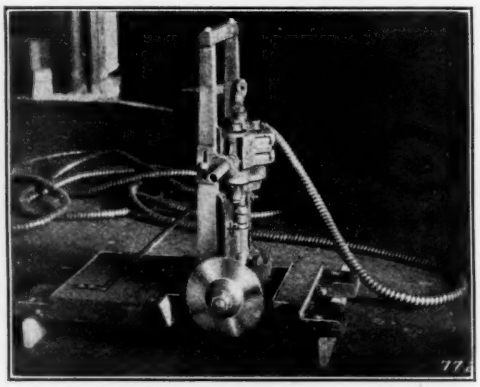


FIG. 1. PORTABLE AIR DRIVEN SAW.

PNEUMATIC LABOR SAVING IN MANUFACTURING

BY CHARLES C. PHELPS

A large New England textile mill has devised several novel ways of using pneumatic drill motors in connection with the work of making alterations and repairs to its buildings. As a result it is making a considerable saving in both time and labor. In many of the processes of textile manufacturing, the looms, spinning frames, and the like, are arranged in rows, leaving alleys between rows for the operators. In time the flooring of these alleys wears down and it becomes necessary to replace it. Ripping up the floor by hand tools means not only a loss in production, due to interference with the machinery and operators, but is slow work and consequently expensive in itself.

The device shown in Fig. 1 was designed to do this work by means of a circular saw. A pneumatic drill motor is mounted on standards attached to a rolling platform. The saw is connected by bevel gearing to the drill spindle. The handles of the drill are held by

metal plates bolted to the sides of the upright frame and the spindle has a bearing in a saddle which is also bolted to the uprights; thus a rigid construction is secured. The motor is a light one, weighing about 15 lb. and operating at about 500 r.p.m. The saw is about 6 in. diameter and is geared to a high speed. In the illustration, the device is shown raised from the floor. In use, the saw is so set as to make a cut the depth of the floor boards. Guide cleats are first nailed to the floor on either side of the alley, then the operator pushes the machine along on its rollers, making a straight cut in hard maple at the remarkable rate of 20 ft. per min., going right through any obstructions, as nails, just as though they did not exist. In softer woods, this speed could be doubled or trebled.

This same device is also used for sawing the new strips of flooring. The tool and its mounting are inverted and set in a special framework with a mitering guide for cutting off the wooden strips on an angle and to exact length. By laying the new flooring on an angle, it was believed that it could resist wear better.

A similar arrangement is useful for cutting out portions of roofing, preparatory to patching. In fact, the device illustrated has been used for this purpose occasionally.

By substituting a rotary planer for the saw or placing a disk faced with sandpaper on the end of the motor spindle, this device could be used for resurfacing flooring.

CUTTING SLOTS FOR BELTING

In many mills the machinery is driven from countershafting on the floor above and the belting must in such cases pass through slots in the floor. This arrangement is often used in a weave room to avoid the nuisance of dirt and dust falling from shafting on the ceiling and also so as not to interfere with the lighting. A convenient appliance is in use at this same mill for roughing out the belt holes in the floor, when new machines are to be installed. It consists of a pneumatic wood-boring auger mounted on an adjustable frame. The wooden base is made in the shape of an H, having a rectangular frame hinged to it at the center and so arranged that it can be set quickly at any angle desired and clamped in this position. The auger is fed by hand in the usual way, the device serving simply to guide the auger. It assures a clean-cut hole at the right angle. This method is fully three times as rapid as the old method of roughing out by hand.

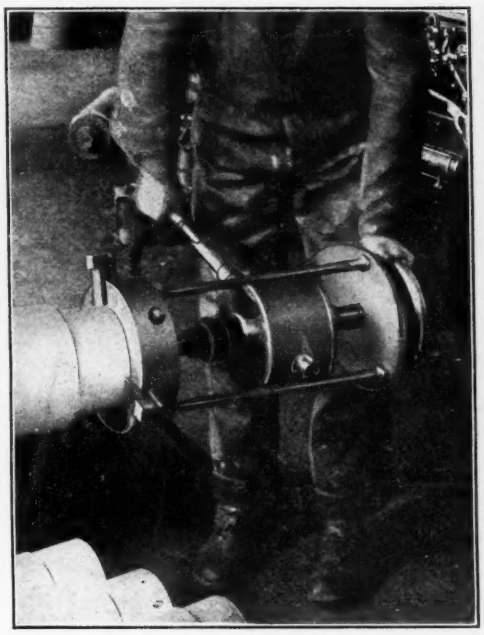


FIG. 2. RECENTERING SHAFTS.

RECENTERING SHAFTS

Fig. 2 illustrates a simple but convenient centering device for use with pneumatic drills. Here it is shown recentering a number of shafts, which are ready for the final turning and grinding after having been roughed out and cut off to length. The device would prove equally valuable to any shop or mill which has to turn a large number of cylindrical metal or wooden parts as rolls, or squeezers; with slight modifications, it could also be used to advantage for boring or drilling holes for shafts, axles, and the like. A universal lathe chuck is connected by three rods with a casting at the back through which the feed screw of the drill passes. The three rods serve as guides for the drill motor. The drill chuck fits a central bushing in the large chuck, thus insuring accurate centering. The universal chuck is quickly secured on the end of the work by the usual socket chuck-wrench. The operator then controls the air supply with his right hand and turns the feed wheel with his left.

An interesting application of a pneumatic

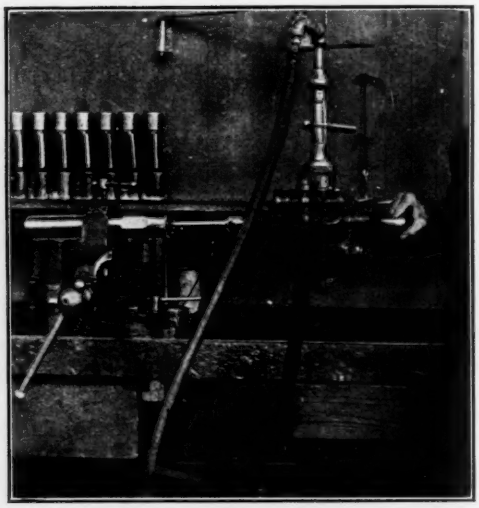


FIG. 3. LAPPING CYLINDER.

wood-boring auger used for lapping the cylinders and valve chambers of riveting and chipping hammers in a shop manufacturing pneumatic tools, is shown in Fig. 3.

The pneumatic motor is suspended from the ceiling by means of a chain and, in place of the auger bit, a rod having a cylindrical plug of suitable material fastened to the end, is inserted in the socket of the machine. The plug is the same size as the drill piston. After applying abrasive powder, the throttle is opened and the plug rotates while the operator pushes the lapping tool into the barrel and withdraws it, repeating the operation several times. ' Ordinarily, the operation of this motor is controlled by a ribbed throttle sleeve on the side handle. A short lever has been attached to this handle, as shown above the motor in the illustration, so that the control is convenient. The motor is of the reversible type; by reversing the motion the lapping operation is very efficient. The lower handle of the drill, which is a "dead" handle, has been removed and a plug inserted in its place. It will also be noted that a length of hose is attached to the exhaust elbow, so as to conduct away the exhaust air instead of letting it blow around the work. The riveter or chipper barrel is held securely in a vise, but is pivoted so as to permit of slight play, which greatly aids in inserting and operating the lapping tool. The pivoting device is clearly shown in the illustration.

Fig. 4 shows a novel manner of using a pneumatic motor in connection with a lifting jack. Jacks containing a plunger actuated by pneumatic pressure have been in use for a long time, but the motor-driven type, shown in Fig. 4, which is known as a "Cayuta" screw jack is of very recent development. The plunger types have certain limitations which restrict their field of usefulness within somewhat narrow limits, but the latter type has a remarkable speed and is made in capacities up to 35 tons.

A regular pneumatic drill motor of suitable size and speed fitted with No. 3 or No. 4 Morse socket is employed. A special extension socket is clamped into the drill socket and fits over the square end of the jack operating spindle. In addition, there is an auxiliary ratchet mechanism that can be operated by hand if desired.

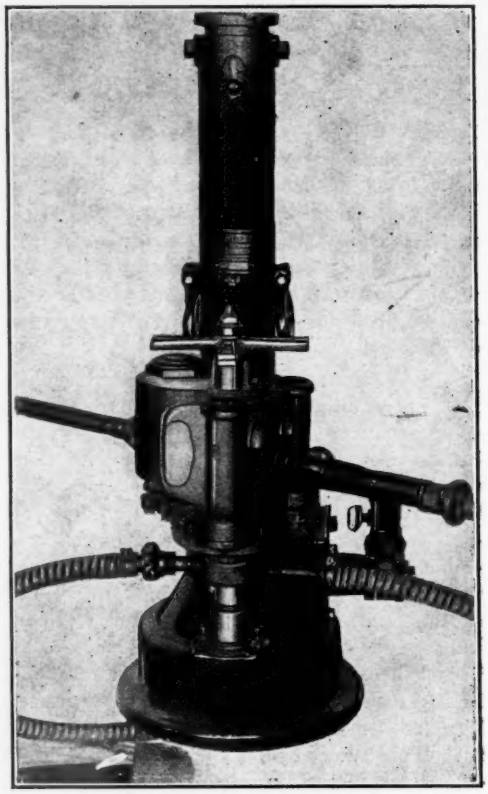


FIG. 4. AIR MOTOR ON SCREW JACK.

If several jacks are in use in one location, one or two motors are sufficient to take care

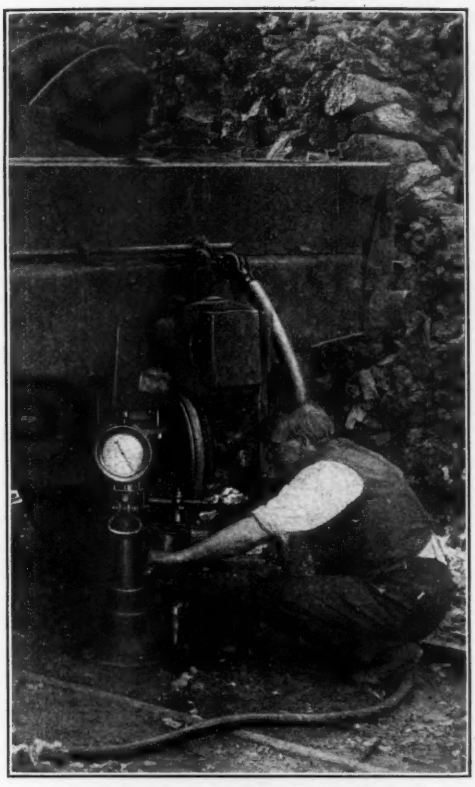


FIG. 5. LIFTING LOADED CAR.

of them. The speed of operation of the jack ranges from 6 to 12 inches of lift per minute, which is probably at least 10 to 20 times faster than standard screw or hydraulic jacks. The motor is conveniently fitted with a short length of hose and quick-detachable coupling so that it can be connected into place without loss of time. Fig. 5 shows one of these jacks employed for lifting the frame of a flat car.

Pneumatic motors of various kinds have rendered excellent service for operating large valves. Four large gate valves in the water mains of a large California city are operated by means of pneumatic drill motors, the valve stem being geared to the spindle of the pneumatic motor. Of course, motors of the reversing type must be employed for such service. These valves are opened in about 2 minutes, whereas it formerly took two or three men 10 minutes. In this case, it was first intended to operate the valve with an electric motor, but the ingenuity of the engineer in charge led him to save this expense by utilizing compressed air, which was already available.

A somewhat similar use is found for small air motors in a New England paper mill, where several 10-inch gate valves at the bottom of pulp digesters are operated by pneumatic motors. These valves have to be opened and closed frequently and the plan adopted has proven far more economical than the old way of manipulating by hand. The power is transmitted by belting from the motor to a pulley on the valve stem.

In another instance, a drill motor of only a fraction of a horsepower, was used for driving a slow-acting but fairly heavy filter press through worm gearing.—*American Machinist.*

FORTY-FIVE YEARS OF AIR BRAKE EVOLUTION

BY A. L. HUMPHREY.*

Forty-five years elapsed between the first trial of the air brake and the death of George Westinghouse. The introduction of the air brake was only its birth. It has had a strenuous infancy, an eventful youth and a recent past of wonderful development. Maturity it cannot reach until transportation by rail ceases to progress. The quick action triple valve, brought out by Westinghouse in 1887, and the high-speed feature of the passenger train brake, added in 1894, have rendered a continuous service which in length of time, universality of application and degree of excellence is unapproached by any other mechanical device in common use at the present time upon railways.

A train in 1890, weighing 280 tons and going sixty miles an hour, had an energy of 33,000 foot-tons. The best air brake of that day could not stop that train in less than 1,000 feet. A train in 1914, weighing 920 tons and going sixty miles an hour, had an energy of 111,000 foot-tons. With the 1890 brake the 1914 train could have been stopped in perhaps 1,760 feet. As it passed the 1,000-foot mark it would still have a collision energy of 48,000 foot-tons (one and one-half times what the 1890 train had before the brake was applied), and it would still have 760 feet to run. That 1914 train with a 1914 brake can be stopped in 860 feet. At that point the same train with an

*Condensed from *Scientific American.*

1890 brake would still be running forty-three miles an hour, with a collision energy of 57,000 foot-tons, or about twice that contained in the 1890 train at the beginning of the stop.

THE BRAKE GIVES MORE THAN SAFETY.

The train running at speed can now be quickly stopped. What follows? That you dare run it at speed. And how does speed effect economy? By increasing the revenue which can be earned in a day by the crew; by the locomotive, which can haul a longer and heavier train; by the car, which will hold more tons; by the trackage, which can accommodate more trains a day; by the traffic solicitor, who can bring more freight and passengers if service is quicker. It is not alone that longer and heavier trains and more of them can be operated at speed, because the air brake will stop them when there is danger. Countless station stops, slow-downs and applications while descending grades are made to one emergency stop. The time saved in such routine operations and the larger use of plant, especially at junctions and terminals, due to quick stopping, is one of the most important results accomplished in the whole brilliant history of organized railway endeavor. Is it surprising that the railways have given and are more and more giving the most eager and systematic co-operation to the manufacturer in the development of air brake improvements?

High speeds, heavier vehicles, longer and heavier trains and their greater frequency increased the amount of work required of the stopping device. The effort consumed in stopping a given train going twenty miles an hour is four times that required at ten miles per hour. The brake shoe, which performs its function through friction against the wheel, is at a disadvantage, which is aggravated as the amount of work required within a given distance increases. A further loss occurs as the greater force is exerted through the foundation brake rigging and because of the longer time taken to obtain full braking power with large cylinders and larger trains. With longer trains, also an increase in the volume of air used interferes with the prompt and uniform response of the brakes to the manipulation of the valve, both when applying and releasing. This makes recharging more difficult and demands a larger available supply of compressed air. Another tendency which was manifested with enlarging train units was that the time elapsing between the action of the brakes at the head end and at the rear end of the train caused a bunching or stretching out of the its smooth handling.
slack between cars, and this interferred with

To enable the brake mechanism to perform this augmented and more complex task, the most obvious and essential step was to insure the best of use of the device as it stood. A poor brake well maintained and operated in the best possible manner will give better service than the best brake if neglected or carelessly handled. This meant systematic instruction of those responsible for handling of trains in service and for the care, inspection and maintenance of the brake mechanism. Both railroads and manufacturers developed trained corps of experts and special methods and apparatus for testing and repairing and provided technical literature and instruction paraphernalia, including elaborately equipped instruction cars and rooms. By organized efforts along these lines increasingly severe service requirements were for a long time partly offset by closer inspection, better maintenance and more care and skill in the handling of the equipment in service. The nature of the mechanism, itself, however, has been rapidly and radically modified.

LATER AIR BRAKE IMPROVEMENTS.

The brake apparatus, in the first place, has been reconstructed so that the mechanism on each car assists in propagating the application in routine as well as in emergency use, thus insuring the prompt and uniform action of all the brakes and affording a more responsive brake for the train as a whole. In "releasing," uniformity and certainty are attained by automatically restricting the release and recharging of the brakes at the head end of the train. This insures greater certainty of response of the brakes toward the rear end of the train and a more uniform action on the train as a whole, and is a large factor in preventing the shocks and strains which cause rough handling and break-in-twos.

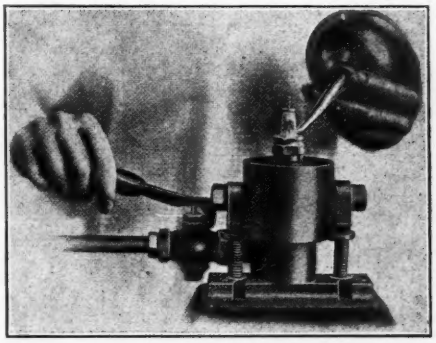
To meet down-grade conditions the "empty and load" type of brake has been evolved. Instead of the ordinary brake, designed to control the empty car, and about one-third as efficient with a loaded car, we have for heavy grades the "empty and load" brake providing a braking force on each car substantially in proportion to its weight. The more uniform

braking of loaded and empty cars improves level as well as mountain-grade service, since any inequality of braking effort on different vehicles in mixed trains of loads and empties produces rough slack action and damaging shocks.

Increased consumption of compressed air took place through greater loss by leakage for longer trains and larger cars, through greater actual use on the larger cars and in more frequent and heavier brake application. To augment the supply of compressed air, compressors of large capacity and high efficiency have been developed.

While the brake could be made quicker acting and more powerful by propagating the application through the train more rapidly, by raising the cylinder pressure and by shortening the time required in obtaining this high maximum pressure, thus making substantially safer the passenger train with heavier cars, it came to be recognized that full results depended upon transmitting the enhanced and quickened pressure to the rim of the wheel efficiently and without material loss. This brings us to the foundation brake rigging—the brake beam and levers—and the brake shoe. Inefficiency in these parts of the mechanism made it impossible to reduce the length of emergency stops on heavy passenger trains going sixty miles an hour to less than 1,200 feet with the most powerful and rapid-acting brake then available. The result has been a highly efficient "clasp" type of rigging; two brake shoes to the wheel instead of one greatly improved the performance of the rigging and relieved the brake shoes, trucks and journals of excessive and unbalanced forces to such an extent as to permit the stops already described at well under 1,000 feet.

Routine or "service" stops, as previously pointed out, are second in importance only to emergency stops. The service functions have been improved so that a fully effective automatic or manual emergency application is possible, even at a moment when a "service" application is in progress. In case the brake-pipe reduction is continued below a fixed minimum danger point an emergency application is made automatically. By the use of electro-pneumatic control the application and release of all brakes can be made uniform and simultaneous throughout the train.



AIR PRESSURE TEST FOR SPARK PLUGS

The disadvantages of a leaky spark plug are many and apparent. Not only does leakage cause a loss of power but the constant rush of inflamed gas through the leak will overheat the plug, cause preignition, which develops engine knocks, and in time the extreme heat will destroy the packing and break the insulator. Even the slightest leak will cause trouble. Incorporated in the severe tests to which the Champion Ignition Co., Flint, Mich., subjects its AC plugs, is one to overcome any possibility of a spark plug leaving the factory in a leaky condition. Each plug undergoes an air test.

The plug under test is inserted in a special fixture and air under a pressure of 150 pounds to the square inch is turned on. The operator then floods the plug with a liquid in such a way that the slightest leak will be indicated by a bubble. Should even the slightest leak occur, the plug is rejected.

Each AC plug is, therefore, perfectly gas tight when it leaves the factory. Further than this the plug is so constructed that it can be taken apart and reassembled without impairing its gas tight properties. This effect is obtained by a copper asbestos gasket and steel washer assembly that insures a tight plug with a minimum of pressure on the insulator.—*Automobile Topics.*

VACUUM TREATMENT FOR PRESERVING TEETH

Pyorrhea—a disease whose symptoms are the inflammation of the gums and the loosening and final loss of the teeth—is a very common malady. It is claimed that half of the persons older than 40 and many younger suffer from it, and that to this cause more than

to any other is due the loss of teeth in old age.

This disease has proved a very stubborn one to control. It is caused by tartar forming between the gum and the tooth, which results in ulceration and the formation of pus. About the only treatment that has so far been possible has been to clean out the tartar and inject antiseptics between the tooth and the gum; but the dental profession has recognized that this procedure is inefficient because it tends to keep the gum and the tooth separated instead of helping them to grow firmly together.

Inventive ingenuity has aided in solving this difficult and important problem. The Sanitor, a machine manufactured by the Sanitor Company, of Chicago, is claimed to provide a successful method of treatment. It is practically a vacuum pump driven by a 1/30 h.p. Westinghouse electric motor. The manner of its use is shown in the illustration. A rubber vacuum cap fits over the teeth and gums, and the little pump applies an intermittent suction. Hence all pus is drained out of the tooth pockets; the gums are thoroughly massaged, and a full flow of fresh, healthy blood is induced. The machine is of course to be used only upon the advice of a competent dentist.

COMPARISON OF RECORDS OF PERCUSSION AND HAMMER DRILLS

The following is the concluding portion of a valuable paper by Mr. Charles E. Hart before the West of Scotland Branch of the Association of Mining Electrical engineers.

The Loeschberg Tunnel was driven by 3⅝-in. diameter percussive rock drills, and the highest footage drilled per month was 1,013 ft. in the soft rock and 574 ft. in hard rock, the average for six months being 342 ft. The heading measured 6½ by 9½ ft. At the Simplon Tunnel, the highest footage was 755 ft. and 426 ft. for six months. At the St. Gothard Tunnel, the highest footage per month was 563 ft. In the Elizabeth Lake Tunnel, in America, the heading was 12 by 12 ft. in granite and the highest footage per month was 466 ft. At the Gunnison Tunnel the heading was 8 by 12 ft. in granite and shale and the highest footage per month was 449 ft. The machines used in the above were invariably of the large-diameter percussive type, but in the Simplon, Brandt rotary drills were also employed. The record footage for one day was done by Messrs. Rothblitz during the construction of the Loeschberg Tunnel; it was 43.3 ft. Last year, however, this record was broken by Messrs. Julius Berger, of Berlin, in the construction of Hauenstein Tunnel in Switzerland, the highest footage for one day being 48.5 ft. This tunnel will be 8 kilometres (nearly 5 miles) long, and the whole work is being done by hammer drills.

This, of corse, does not prove that the hammer drill can bore faster than the percussive rock drill, but it goes to prove its adaptability. Their economy and the comparative boring speed is dependent on conditions and the nature of the rock. The chief interest, however, lies in the fact that they are now being used for this class of work with marked success, which further justifies the contention that they are becoming the prevailing drill. To compete with the hammer drill in point of cost, the percussive machine must do 2½ to 3 times as much work in a given time, owing to its greater cost, greater air consumption, and greater labor required. For instance, taking 100,000 cu. ft. of air per hour at 80 lbs. pressure as costing, say, 15s; in eight hours actual boring time, the percussive rock drill at 120 cu. ft. per minute consumes 56,000 cu. ft. of air, equal to 7s. 6d.; while in the same time a hammer drill taking 30 cu. ft. per minute would consume 14,400 cu. ft., equal to 2s. 1d. The following may be taken as a fair average of what a hammer drill will do, provided good drill steel is used with correctly tempered bits:

	Inches Per minute.
Boring speed in hard granite	4
" " " ordinary granite ...	6½
" " " ordinary whinn	5
" " " hard whinn	4
" " " limestone	10
" " " freestone	10
" " " coal	8 to 24

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COMPRESSOR AND DRILL DEVELOPMENTS

One of the greatest and most unfailing of all the businesses of New York is its own business of growing. An increase of over one-sixth of a million in population every year must be provided for by a constant reaching out into new lands all around it, building upon it and fitting it with all the facilities of urban life. Water, sewerage, illumination and transportation are all to be provided for, and in all these the engineer, or, more properly, the engineering contractor is a principal agent, There are always jobs awaiting him in the city just as surely as for a lawyer.

Of all the public utilities for which the contractor is responsible the one which seems never to catch up with the demand is that of local passenger transportation. New lines of urban and interurban travel are inadequate from the moment of their completion. The existing subway system, which was at first a wonder merely for its magnitude and its vast carrying capacity, is uncomfortably, indecently, and even dangerously overcrowded at certain hours.

Just now the construction of other and still more omnivorous subways is getting under way and we are specially interested in some of the devices employed upon the work. As all depends upon the contractor so he is dependent upon the mechanical facilities which may be available, and chief among these are the air compressor and the rock drill. These have an established status and are both absolutely reliable under suitable conditions, but with both of them constant strenuous employment has led to successive improvements which have greatly increased their efficiency.

Efficiency is the life of the successful contractor, and he unhesitatingly pays the price. The big steam power houses for the compressors were all right when they were the up-to-date thing, but they were costly both to instal and to operate and in the later contracts they are conspicuous by their absence. Instead we see—when we can find it—the small electrically driven plant, more numerous and more conveniently located with little cost for attendance. It is also noiseless, which is one of the changes which have come to the compressor itself. An entirely new system of air valves, both for inlet and discharge, phenomenally light and free of movement, give clearer passage for the air and permit in-

creased speeds with commensurate augmentation of capacity.

There has come over the rock drill and rock drilling practice a greater change than that which has befallen the air compressor. It is not, however, that the drill has been improved so much, but that it is being superseded. The reciprocating drill is giving way to the hammer drill. The tripod drill, with its heavy weights, requiring the constant attendance of two men, is giving way to the one-man drill, which wastes no time from hole to hole, accomplishes more work day by day, and with a great reduction in operating cost.

It is idle to discuss how and why these changes are occurring. The self-interest of the contractor has been the final arbitrator, and while he has been seeking only his own profit his decision must have weight wherever air compressors and air actuated rock drills are employed.

NEW BOOK

Pumping by Compressed Air, by Emund M. Ivens, New York, John Wiley & Sons. 250 pages, 6x9 in. 106 illustrations, numerous tables. $3.00.

Just one-third of this book is devoted to air compression, air compressors and related matter already to be found in many books and with nothing new or original. In fact no originality can properly be claimed for any portion of the book. Various information is presented concerning the different systems of employing compressed air for raising water, numerous formulas and tables from various sources are given which should be of service to those who have no better means of informing themselves on the subject.

HAMMER DRILL SHANKS

BY PARIS HIATT.

The introduction of Hammer Drills has brought with it some new points in the making and handling of drill steels which up to the present time are not as thoroughly understood as they should be in order to get the best results from this type of drill. Inasmuch as the writer has made a special study of this class of work during a number of years, both in America and in Europe, he feels that a few words on this subject will be of benefit to many

In all types of hammer drills where the hammer or piston strikes the steel directly, it is necessary to make a special shank on the steel, with a collar set at a certain point to prevent the steel from extending too far back in the chuck, and thus shortening the stroke of the piston. The cross section and dimensions of collar and shank are determined by the type of drill. The important point, however, is to keep the shank to the proper size and length, with a square, smooth striking surface.

When a shank becomes broken it should be removed at once from the machine, as in a very short time the striking face of a piston or hammer will be ruined when working on a broken or uneven shank end. Also small pieces of the broken shank are liable to work back into the machine and score the cylinder. Likewise when the striking end of a piston becomes broken it should be replaced at once, as one bad piston will ruin many shanks in the course of a day. There are several ways in which a drill operator can tell when a piston or shank breaks, the most common of which is by sparks flying from the front head.

In other types of hammer drills, in which the hammer or piston strikes an anvil block, which in turn strikes the steel, no collar is necessary on the steel, as the anvil block prevents the steel from extending too far back into the machine. However, the length, cross section and striking face of the steel should be given as much attention as in the former type. Too small shanks produce excessive wear on the chucks, and bad striking ends will ruin the anvil blocks.

The proper temper for shanks depends on the quality of the steel, but in all cases an easy way of testing is with a file. If the file slips over the shank end, not taking hold, the temper is too high and the shank will break. If the file takes a firm hold on the shank end the temper is too low, and the shank will upset in the chuck. So a happy medium, namely when the file just touches the shank end, is the proper hardness and should be rigidly adhered to. A good method for inspecting shanks and one that takes but little time, is to supply the blacksmith's helper with a suitable gauge and when he sorts the steel for the fire he can quickly apply the gauge and lay the bad shanks in a pile for repairing.

Both in the blacksmith's shop and under-

ground the steels should be stood with the bits down. In solid steels this keeps mud and dirt from the shanks and in hollow steels it keeps dirt from the hole in the shanks, which is very important for the following reason: The hole in the bit is usually conical with the bell of the cone outward, corresponding with the blacksmith's punch; therefore the point of the cone is usually smaller than the hole in the steel and dirt passing through the steel from the shank end will usually stop at this point and then the hole is plugged. For the same reason it is more difficult for dirt to enter the steel from the bit end, and what collects in the cone can easily be knocked out by a few raps of the steel against a stone. This point is extremely important in steels for drills that have a water tube extending a short distance into the shank, for in such steels the hole for the tube is larger than the hole in the steel, and if dirt is in the shank the water tube will be plugged or broken as the steel is inserted in the chuck. A little care and system in the handling of steels will not work a hardship on either the miners or blacksmiths, but will save endless trouble underground, in the blacksmith shop and in the repair room.

At the present time the writer knows of only one machine which has proved a practical success in making all types of shanks and drill bits; this is the Leyner Sharpener marketed by the Ingersoll-Rand Co. It accomplishes the work both rapidly and accurately by means of shank end formers, upsetting dies and forming blocks. Furthermore, the experience is in the machine itself, and in many places it is being worked satisfactorily by most ignorant workmen.

St. Petersburg, Russia, July. 1914.

SNOWSTORM HYDRO-ELECTRO-PNEUMATIC POWER COMBINATION

A novel hydro-electro-pneumatic installation has recently been made by the Snowstorm Mining Co., operating in the Coeur d'Alene district, Idaho. The plant consists of a 300-hp. air compressor, rope driven by a Pelton water wheel and an induction motor direct-coupled and working either independently or in parallel with the water wheel unit, when the latter rotates at 347 r.p.m.

Due to the variable water supply available for the wheel, and the continuous operation required of the compressor, it was necessary to install a 250-hp. electric motor to help out during the period that the water wheel was unable, from lack of water, to drive the compressor at the required load and speed.

Current for the motor is secured from a transmission line of a commercial plant supplying the district. Mounted on the electric motor shaft is a 46-in. rope sheave which drives a 14-ft. sheave on the compressor. The compressor sheave is grooved for nineteen 1¼-in. Manila ropes, and the sheave is cast with sufficient weight to permit obtaining the requisite fly wheel effect for the compressor's operation. The American system of rope transmission is employed, the tension sheaves and re-winders being placed above the driving ropes, and located in such a manner as to conserve floor space and head room to the greatest extent.

The water-wheel equipment consists of a twin runner Pelton-Doble tangential water wheel unit; one runner being approximately 44 ins. in diameter, and is capable of developing 325 hp. when running at a speed of 347 r.p.m. This speed also coincides with the full load speed of the induction motor. The other wheel is approximately 72 ins. in diameter and develops 250 hp. at a speed of 212 r.p.m. Both water wheels are keyed on the same shaft, which is extended and coupled to the electric motor shaft, carrying the driving sheave. One or the other wheel must develop the requisite power when running at its correct speed; in this event the idle wheel, the pressure water being shut off from same, simply rotates on the shaft without performing any work other than providing additional fly-wheel effect for the installation. Both wheels never develop power at the same time.

The requirements of the plant call for the highest efficiency over a wide range of operating conditions, involving approximately a 300 per cent. fluctuation of the power water supply, and a variation of the compressor speed, hence the power required for same depending upon the demands on the air line. It is necessary, during certain times, that 300 hp. be delivered to the compressor sheave when the latter rotates at 95 r.p.m.

If there is sufficient water available the 44-in. Pelton wheel develops this power without assistance from the electric motor. Should the water supply be insufficient, current is applied to the electric motor to supply the de-

ficiency. At other times, and over a period of several hours' duration, the compressor output is reduced to an amount corresponding to 58 r.p.m. In this event the water for the 44-in. Pelton wheel is shut off and it rotates idly, while the 72-in. Pelton wheel is allowed to develop the power, without assistance from the motor. While either wheel may develop its full power when operating at its correct normal speed of 347 r.p.m. for the 44-in. wheel, and 212 r.p.m for the 72-in. wheel, quite a wide variation of speed below normal may be secured; hence a most flexible installation has been secured.

The novelty of this plant consists of the application of a variable speed, variable power tangential water wheel unit to a constant speed induction motor, driving a compressor. The plotted efficiency curves of the water wheels is quite flat for a range of power between 220 and 300 hp. for the 44-in. wheel when rotating at 347 r.p.m, and for the 72-in. wheel between 160 and 230 hp. output at 212 r.p.m.

For slight reductions of speeds below normal the efficiency holds up remarkable well, as was predicted. These results are obtainable from the type of ellipsoidal water wheel buckets employed in conjunction with needle regulating nozzles. The latter discharge a perfectly circular, solid jet under variations corresponding to full load of the respective wheels, down to about 10 per cent. of the maximum load.—*Min. and Eng. World.*

HAMMER DRILLS AND PERCUSSION DRILLS COMPARED

BY P. B. MC DONALD.*

Drill steels can be changed more quickly with a hammer machine than with a reciprocating machine because the steel rests loosely in the chuck and does not require the careful tightening which a reciprocating drill chuck does. The time spent changing drills may seem only a small detail; but it is noticed in the records that half as much time was consumed in doing that as in net drilling time, so that for 2 hours of actual drilling as much as one hour might be spent in changing steel. It is wise to economize on such an important detail.

*Extract from article in *Canadian Mining Journal,* June 15.

The mounted, screw-feed, hammer drill can be set-up, adjusted to the correct distance from the face of the rock, and the holes pointed advantageously, with greater facility than a reciprocating drill, because the stroke of the machine is taken care of in the cylinder and does not affect the drill steel or chuck. It helps to save time in several of these auxiliary operations. In starting a new hole with a reciprocating drill, especially a "cutting-in" hole at a glancing angle to the face of the rock, the air can only be turned on half-force for a few minutes or the blows would slide off the rock. As a hammer drill uses many light blows in place of a smaller number of heavy blows, the holes can be started with more precision, and inequalities on the surface of the rock are not so likely to deviate the drill.

There can be little doubt that a hammer type drill is theoretically a more efficient and scientific machine for cutting a hole than is a reciprocating type. In the latter type power is consumed in overcoming friction and inertia of the drill-steel. This in a six-foot length of hole may be a considerable item, due to the drill steel rubbing against the sides of the hole as it is reciprocated and turned. In the hammer type the only weight moved is the hammer alone, which imparts all its energy through the drill-steel to cut the rock. More practical, if smaller, considerations are that the miner's helper is not liable to have his knuckles barked by a reciprocating and rotating chuck, and the miner can feed the machine ahead until the chuck fairly touches the rock, whereas with a reciprocating drill, he would probably stop it an inch from the limit of the feed, due to not being able to distinguish the whereabouts of the swiftly moving chuck. These are small points, but it is on record that miners have refused to use a certain make of machine because the crank-handle was not rounded, but was so sharp-ended as to hurt the hand of the man who turned it.

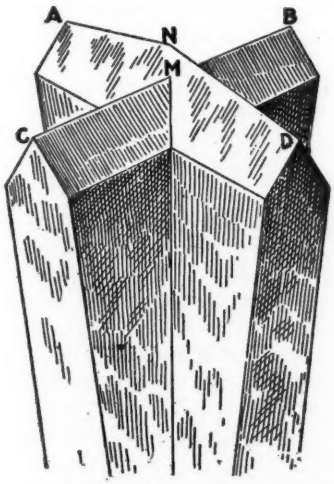
The hammer types have some disadvantages In the earlier makes difficulty was experienced in keeping the cutting face of the drill-steel close against the rock, so that the full force of the blows was sometimes lost. The latter types, more carefully made, have improvements which obviates this.

In a hammer drill, the drill-steel may be struck over a thousand blows per minute. From 10 to 15 per cent. of these blows may be

struck when the bit does not touch the bottom of the hole, because a piece of hard steel cannot be hammered and pressed against rock without bouncing back. The troubles of broken drill-steel are due partially to this, but are not serious with good steel.

Also there are some varieties of rock, clayey or sticky, which drill better with a drill-steel churning and plunging in the muddy chippings, which refuse to wash away, than with the hammer drill. The reciprocating drill splashes the hole clean, better than the hammer type, in such rock.

As to the advantages of the "stoper" hammer drills or of the hand sinkers, such as the Jackhamer, little need be said. It is pretty well accepted that the one-man stoper drill has revolutionized over-hand stoping and raising all over the world. In many mining districts, as on the Marquette Range, Michigan, an enormous number of stopers are in use. In a few districts, such as the Birmingham iron mines, Alabama, they were tried and not liked. The little hand-sinkers have risen suddenly to fame for down-holes, especially since automatic rotation types came out. For shaft-sinking they are time-savers, as much for the facility with which they can be taken out of the way at blasting time as on account of the much greater number of machines which can be operated in the confined space.



A NEW KINK IN DRILL BITS

The sketch here reproduced from Engineering and Mining Journal, sent in by Mr. Frederick W. Foster, shows a bit designed by H. Emens which has been used exclusively for the last two years at the Portland mine, Victor, Colo. During the year after its use, there were 34,000 fewer bits sharpened than during the preceding year, while 7 per cent. more drilling was done. These bits are made of the same steel as the old ones, the only difference being in the fact that one set of wings is raised in the center. The raised part acts as a guide for the rest of the bit and causes the cuttings to come out coarser. The wear on the bits comes at the edges, the centers not being worn appreciably. The points *A, B, C, D,* are in the same plane. On 1 1-2 in. bit *N* is 3-16 in. above *M*.

A NEW SWISS TUNNEL

The Hauenstsin Tunnel on the Basle-Olten line in Switzerland was holed-through on July 10. The tunnel is 5 miles 94 yards long and was commenced Feb. 1, 1912. It and its approach lines will replace the existing line between Sissach and Olten. There is practically no difference between the lengths of the old and the new lines. On the former there is a tunnel a mile and a half long; there is a gradient of 1 in 38 for about 4 miles, and the rest of the route has a gradient of 1 in 48. On the new route the maximum gradient will be 1 in 95, and in the tunnel the gradient will be 1 in 133 for 4½ miles and 1 in 666 for the remainder. The contract price for the tunnel was a trifle under $4,000,000. It has been thus far completed about eighteen months ahead of the contract time.

FISHES AT GREAT DEPTHS

On the cruise of the Prince of Monaco in the North Atlantic in the summer of 1913, interesting studies were made of species of fish which normally inhabit depths of over 3,000 feet in the ocean, and which come as near the surface as 300 feet, during the night only. As the pressures at the depths mentioned would be over 1300 and 130 lb. per sq. in., respectively, the fish have a facility of decompression and recompression which New York sand hogs might envy. In the American Museum of Natural History, New York, there is an exhibit of models of deep sea fishes with an ingenious arrangement for showing their phosphorescent or self illuminating peculiarities.

NOTES

The cut on page 7349 of our September issue, showing the "works" of a pneumatic electric air drill built by the Pneumelectric (not Pneumatic as carelessly misprinted) Machine Company, Syracuse, N. Y., should have been credited to Engineering News, from whose page it was taken.

A big floating dock is being constructed at Odessa which is said to be the largest in the world. It will cost about $2,000,000 and will be capable of carrying a vessel of 40,000 tons.

In draining Kerr lake at Cobalt, Ontario, the pumps removed 325,000,000 gal. of mud and water at an average of 6000 gal. per minute for 38 actual working days.

A lately developed use of compressed air is for the cleaning of furs previous to their storage for the summer. A nozzle is used with a very minute opening, say 1-64 inch, and 4 to 6 inches long. This is carefully run all over the fur to dislodge dirt and eggs, which it does thoroughly and without injury.

The great Chicago, Milwaukee & St. Paul Railroad tunnel through the Cascade Mountains, in the State of Washington, which is 12,000 ft. long and will reduce the altitude of the crossing 443 ft., was broken through by a blast August 4, and men from east and west clasped hands through the gap. The tunnel will save four miles in distance and will avoid the enormous snowfall of the summit.

Some 12,517 men are now at work in the construction of subway systems in New York City, according to the last report of progress of Alfred Craven, chief engineer of the Public Service Commission. It appears that more than half the work is now under contract, but that when all contracts have been let, a matter perhaps of only a few months, the number of men will be almost doubled. The city has $126,414,000 in contracts, in progress or completed.

A novel wax bleaching plant at Bruitford, England, consists essentially of an electrically driven blower, an air cooler, a battery of five ozonizers, and the vessel in which the material is treated. The ozone produced is led to the bottom of the treating vessel, and passes up through the molten wax in fine jets, effecting the bleaching of the wax.

The Central R. R. of New Jersey will install a large electro-pneumatic interlocking system at the new station and yard in Jersey City, N. J. On completion of these improvements this road will have a continuous electro-pneumatic system, both for interlocking and block signals, on the four-track line from Jersey City terminal to Bound Brook, N. J.

One pound of carbon burned to carbon dioxide (CO_2) gives 14,540 B.t.u., but if burned only to carbon monoxide (CO), it gives only 4380 B.t.u., or only about 30 per cent. of its full value. Oil burned to (CO) gives about 60 per cent. of its full value; therefore, as regards heat development, the more complete the combustion is, the better. However, to obtain complete combusion to (CO_2), it is ordinarily necessary to supply considerably more than the theoretical proportion of oxygen.

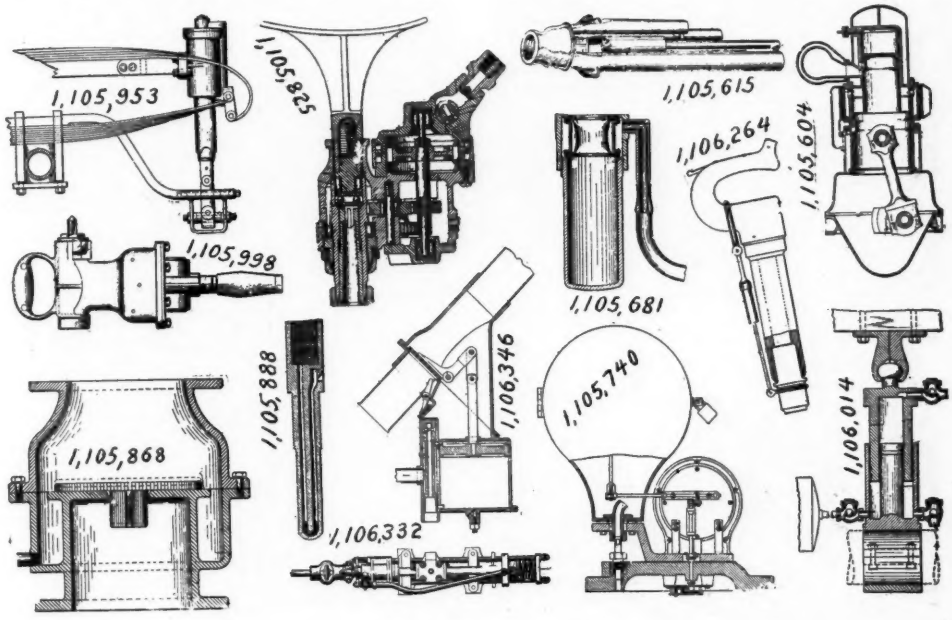
Dynamite inserted in lengths of condemned fire hose was used to cut to pieces the steel drill barge "Teredo" which had been sunk at Panama by an accidental explosion. It having been found impracticable to raise it, it was decided to cut it to pieces. The hose with its charge of explosives was placed along the line at which it was desired to direct the force of the blast and, according to the "Canal Record," made a fairly clean cut. The sections sheared off were raised by wrecking barges assisted by a dipper dredge.

Professor Vivian B. Lewis said, in a recent hearing before the Hayward's Health Gas Co., that if they mixed 5 per cent. or more of petrol vapor with air, they got a mixture which would burn quietly and was not explosive, but it was explosive between the limits of 5 per cent. and about 1.6 per cent. of petrol vapor. A gas which had only got 1.8 or 1.6 per cent. of petrol vapor in it was highly explosive.

The fastest time ever made in American waters by any sort of craft was made on July 3, 1914, by the hydroplane "Kitty Hawk VI" on the Illinois River at Peoria, Ill. A measured mile was covered in 1 min. 6 sec., or at

the rate of 54.54 miles an hour. This tiny vessel, only 23 ft. long, has a 24-cylinder gasoline motor, generating 300 hp. at 1,600 revolutions per minute.

At Mt. Morgan Mine, Queensland, Australia, all the underground air mains are arranged so that they may be used also as water mains, carrying water at high pressure for emergency fire service. The arrangement is said to be highly satisfactory.



PNEUMATIC PATENTS AUGUST 4.

Electric Lights for Use in Gas Charged Rooms should be low candlepower carbon lamps, acording to tests made by the Bureau of Mines. These tests showed that when incandescent lamps of high candlepower were broken in an atmosphere charged with inflammable gas, the gas was ignited in a large proportion of the cases.

Three cases are reported (in England) of oil explosions in the crank chambers of high-speed engines. Two of these occurred in gas engines and the other in a steam engine, all the engines being of the enclosed type with superposed cylinders. The constant agitation of the lubricating oil by the engine cranks not only raises the temperature in the crank chamber, but causes a fine spray or mist of oil to be produced. This mist contains oil particles in such a finely divided state that it requires only a spark or overheated surface to cause ignition. In the case of gas engines the trouble has been overcome by the removal of the combustible gases by means of plenum ventilation.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 4.

1,105,604 ENGINE CONSTRUCTION. CHARLES H. BARTLETT, Elizabeth, N. J.

1. In an engine construction, a foundation structure including a crank case, an air compressing cylinder, a working cylinder in tandem arrangement with the compressing cylinder, and a supporting housing for the compressing cylinder, an air reservoir or receiver located between the compressing cylinder and housing, connections between the air receiver and working cylinder for admitting compressed air thereto, and a valved connection between the air receiver, and the compressing cylinder.

1,105,615. AUTOMOBILE-HORN. CHARLES J. BRINKMANN, Glencoe, Minn.

1,105,669. RIVET - SET RETAINER. AXEL LEVEDAHL and REINHOLD A. NORLING, Aurora, Ill.

1,105,681. SUCTION-CUP FOR MILKING-MACHINES. OTTO A. MOLDENHAUER, Watertown, Wis.

1,105,740. VOLUME AND PRESSURE REGISTER FOR FLUIDS. THOMAS B. WYLIE, Pittsburgh, Pa.

1,105,825. PNEUMATIC TURBINE - DRILL. REINHOLD A. NORLING, Aurora, Ill.

1,105,868. EXTRACTOR OF LIQUORS AND SOLIDS FROM GASES. JOHN T. WILKIN, Connersville, Ind.

1,105,876. PNEUMATIC TOOL. GOTTLIEB BRIEGEL, Fond de Lac, Wis.

1,105,888. HOT-BEARING ALARM. ELMER O. DAVIS, Denver, Colo.

2. A device of the character described constructed to be used in connection with the air supply system to the brakes of a train, comprising a casting having a U passage formed therein, an air pipe connecting one end of said passage with the train supply system, and the other end of said passage free to exhaust to the atmosphere, the casting so constructed that the loop of the U passage may be placed and held in proximity to the bearing of a wheel axle, and a fusible plug located in the bend in such a position that as the bearing becomes heated to a great degree, the plug will liquefy and be discharged from the passage by the pressure of the air thus permitting the air to escape and reducing the pressure to such an extent that the brakes will be set.

1,105,942. SUCTION CLEANING APPARATUS. EDWARD M. WARING, New York, N. Y.

1,105,953. PNEUMATIC SHOCK-ABSORBER. RALPH E. BATES, Philadelphia, Pa.

1,105,987. GAS AND AIR MIXER. WILLIAM B. MCSORLEY, St. Louis, Mo.

1,105,998. FLUID-OPERATED DRILL AND HANDLE THEREFOR. CAID H. PECK, Athens, Pa.

1,106,014. SHOCK-ABSORBER. RAYMOND R. WALKER, Follansbee, W. Va.

1,106,202. MILKING-MACHINE. JAMES C. GORDON, Calgary, Alberta, Canada.

1. In a milking machine, a teat press comprising a sectional plunger adapted to manipulate a teat, fluid pressure cylinders, connections between said cylinders, a piston in each cylinder, a piston rod connected to each piston and to one of the sections of said plunger, a spring within each cylinder and holding the piston therein normally against movement under the action of fluid pressure and of a strength different from that of the spring in the other cylinder, and a source of fluid supply for said cylinders whereby the pistons therein will be actuated successively against the action of the springs.

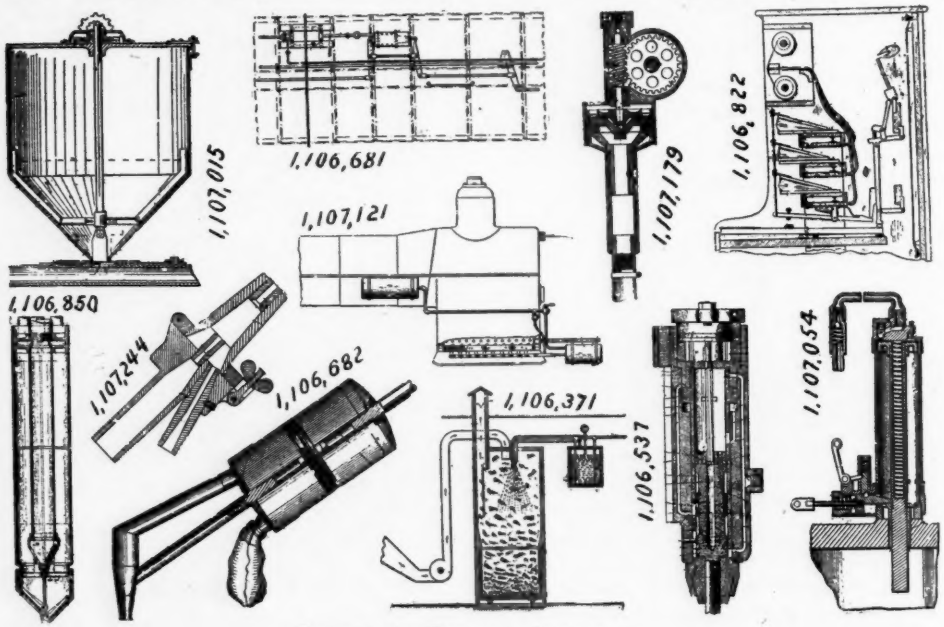
AUGUST 11.

1,106,371. ART OF CARROTING FUR. PHILLIP C. DONNER, Summit, N. J.

3. An improvement in the art of carroting fur which consists in blowing cut raw fur into a receptacle at the top and spraying a carroting solution into said receptacle at the top into contact with the moving fur therein.

1,106,411. HAIR-DRYING COMB. GEORGE L. SCHEEL, Chicago, Ill.

2. A device of the kind described comprising a comb having a hollow body with both ends thereof open; a spider in said body near one end thereof and having a recess therein; a cap provided with a recess therein and fitted in the other end of said body; a heating element disposed in said hollow body and supported in said recesses; and air pumping means connected with one end of said body and adapted to force air over said heating element, substantially as described.



PNEUMATIC PATENTS AUGUST 11.

1,106,537. ROCK-DRILL. GEORGE J. BEAUDIN, Flat River, Mo.

1,106,681. PRESSURE - INDICATOR. WILLIAM H. SAUVAGE, New York, N. Y.

1,106,682. SUCTION-CREATING MECHANISM FOR VACUUM CLEANING APPARATUS. JULIUS SCHIRRA, Pittsburgh, Pa.

1,106,695. NOZZLE FOR PNEUMATIC CLEANERS. JOHN F. BOYN, New York, N. Y.

1,106,820. PLAYER - PIANO PNEUMATIC BELLOWS. JOSEPH KNAGGE, Chicago Heights, Ill.

1,106,822. PNEUMATIC PIANO. CLAYTON A. LAMBERT, Indian View, Ohio.

1,106,850. DEEP-WELL PUMP. JOHN L. SEBASTIAN, Salt Lake City, Utah.

1. In a deep well pump, the combination of exterior and interior cylinders, webs connecting said cylinders and dividing the space between them into chambers, a head fitting snugly within the exterior cylinder and connected to the upper end of said interior cylinder, and having apertures registering respectively with the interior cylinder and the chambers, a discharge pipe connected with the interior cylinder, a jet pipe communicating with the discharge pipe above said interior cylinder, pipes connected with said chambers for supplying compressed air thereto and exhausting therefrom, a valve casing connected to the lower end of the interior cylinder and having openings communicating with said chambers, a valve adapted to alternately close said openings, an inlet casing connected to the lower end of the exterior cylinder having a partition forming with said casing

1,107,381. ELECTROPNEUMATIC BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,107,414. DIVER'S AIR-PUMP. JEAN F. DERAY, Sunnyvale, Cal.

1,107,425. VALVELESS PUMP FOR CONVEYING GASES. WALTER HOHAGEN, Charlottenburg, Germany.

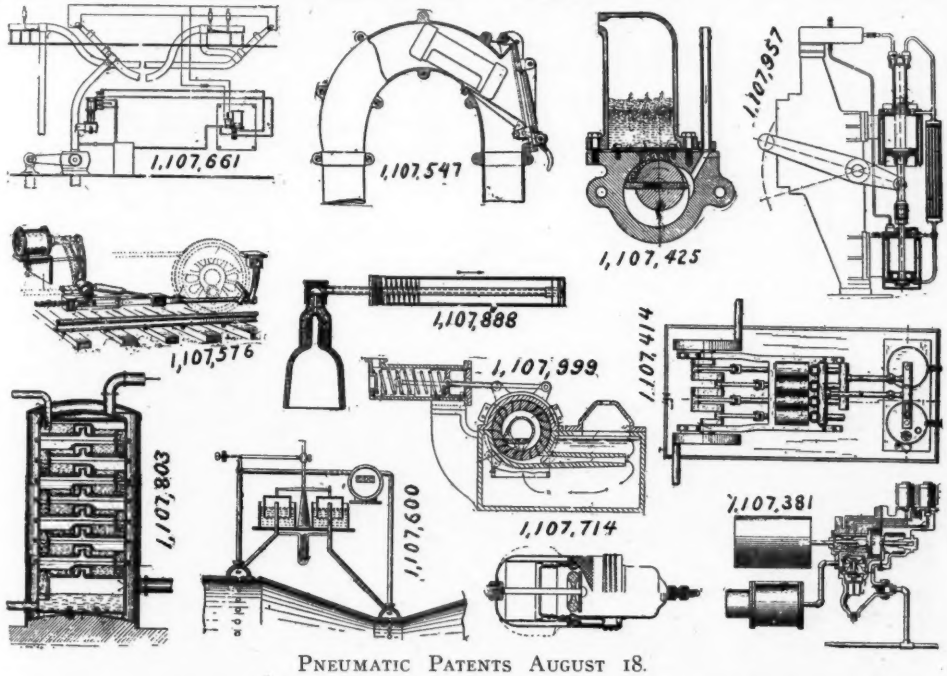
1,107,547. PNEUMATIC-DESPATCH - TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

1,107,550. PNEUMATIC HAMMER. GEORGE LAWSON ROBERTSON, Philadelphia, Pa.

1,107,554. PNEUMATIC ACTION. ADOLF A. STEINHILBER, Rock Island, Ill.

1,107,564. VACUUM STREET - SWEEPER. EDWARD K. WARD, Davenport, Iowa.

1,107,571-2-3-4-5. AUTOMATIC PNEUMATIC MUSICAL INSTRUMENT. WILLIAM F. BAYER, Buffalo, N. Y.



PNEUMATIC PATENTS AUGUST 18.

compartments respectively communicating with said chambers, said compartments having inlet openings, and non-return valves closing said openings.

1,106,937. AUTOMATIC REACTING SIPHON AIR-PUMP AND STOPPER. ABBOT PORTER GOFF, St. Joseph, Mo.

1,107,015. DUST - SPRAYING MACHINE. HENRY D. BABCOCK, Leonardsville, FRANK C. WELLS, Holland Patent, and JAY W. BROWN, River Forks, N. Y.

1,107,054. PUMP ATTACHMENT FOR MOTOR-VEHICLE ENGINES. FREDERICK G. FOLBERTH, Cleveland, Ohio.

1,107,121. AIR-FEEDING AND AIR-OPERATED GRATE. ALBERT E. SHULTZ, Pinners, Va.

1,107,179. PNEUMATIC TOOL. OSCAR W. NORBERG, Alamosa, Colo.

1,107,244. SAND-BLAST NOZZLE. ALBERT CARTER, New York, N. Y.

AUGUST 18.

1,107,284. VALVE STRUCTURE FOR AIR-COMPRESSORS AND THE LIKE. JOHN WILLIS GARDNER, Quincy, Ill.

1,107,576. AUTOMATIC ADJUSTING DEVICE FOR BRAKES. CHARLES ALBERT BOOTH, Brunswick, Md.

1,107,600. REGISTERING-METER FOR GAS AND THE LIKE. WALTER H. FULWEILER, Moylan, Pa.

1,107,661. PNEUMATIC-DESPATCH - TUBE APPARATUS. MERTON L. EMERSON, Braintree, Mass.

1,107,714. PNEUMATIC SPRING. ARCHIBALD SHARP, London, England.

1,107,744-5. APPARATUS FOR THERAPEUTIC TREATMENT OF AIR OF A SICK-ROOM. FRANK BATTER, St. Johns, Oreg.

1,107,803. PROCESS OF SEPARATING THE HYDRO-CARBONS CONTAINED IN NATURAL GAS. HEINRICH KOPPERS, Essen-on-the-Ruhr, Germany.

1. Process of separating hydrocarbons contained in the natural gas which consists in driving said gas under pressure into a wrought iron jacket, and conveying the gas from said jacket into a cast iron bell washer inclosed by the jacket and containing a hydrocarbon-dissolving oil, whereby the bell washer is subjected to like exterior and interior pressure.

1,107,888. THERAPEUTICAL VACUUM APPARATUS. CHARLES E. BUCK, Boston, Mass.

1,107,957. APPARATUS FOR COMPRESSING AIR AND OTHER ELASTIC FLUIDS. EDWIN W. JONES, Ipswich, England.

1,107,999. ROTARY ELASTIC-FLUID PUMP. JOSEPH PETERMOLLER, Cathcart, Glasgow, Scotland.

AUGUST 25

1,108,136. PNEUMATIC-DESPATCH APPARATUS. RODERICK G. COLLINS, JR., New York, N. Y.

1,108,137. APPARATUS FOR CONTROLLING THE MOVEMENT OF CARRIERS IN PNEUMATIC - DESPATCH APPARATUS. RODERICK G. COLLINS, JR., New York, N. Y.

1,108,149. ELECTROPNEUMATIC BRAKE-VALVE. EDWARD H. DEWSON, New York, N. Y.

1,108,170. PRESSURE - RETAINING - VALVE DEVICE. THEODORE A. HEDENDAHL, Denver, Colo.

2. In a fluid pressure brake, the combination with a train pipe and triple valve device, of a valve for controlling the release of air from the brake cylinder through the triple valve exhaust port, a movable abutment subject in one direction to train pipe pressure tending to close the valve and in the opposite direction to brake cylinder pressure tending to open the valve, and means for neutralizing the effect of the train pipe pressure on said abutment to a predetermined extent.

1,108,247. VACUUM-PRODUCER. EUGENE A. SCHENCK, Kansas City, Kans.

1,108,248. SUCTION - CLEANER. GEORGE C. SCHMITZ, Racine, Wis.

1,108,275. VACUUM RENOVATING APPARATUS. JOSEPH H. TEMPLIN, Philadelphia, Pa.

1,108,280. FLUID - PRESSURE - BRAKE APPARATUS. WALTER V. TURNER, Edgewood, Pa.

1,108,285. PNEUMATIC DRIER. JOHN MOULTRIE WARD, Washington, D. C.

1,108,291. PNEUMATIC ENGINE-STARTER. GRANVILLE G. WESTERFIELD, Indianapolis, Ind.

1,108,293. PNEUMATIC - DESPATCH - TUBE SELECTIVE SYSTEM. FREDERICK G. WHITTIER, Brookline, Mass.

1,108,334. APPARATUS FOR AERATING AND IRRIGATING SOIL. LUCIAN W. CARR, Crawfordsville, Ind.

1,108,342. MINE DRILLING AND CHANNELING MACHINE. LONGFELLOW J. DAFT, Seattle, Wash.

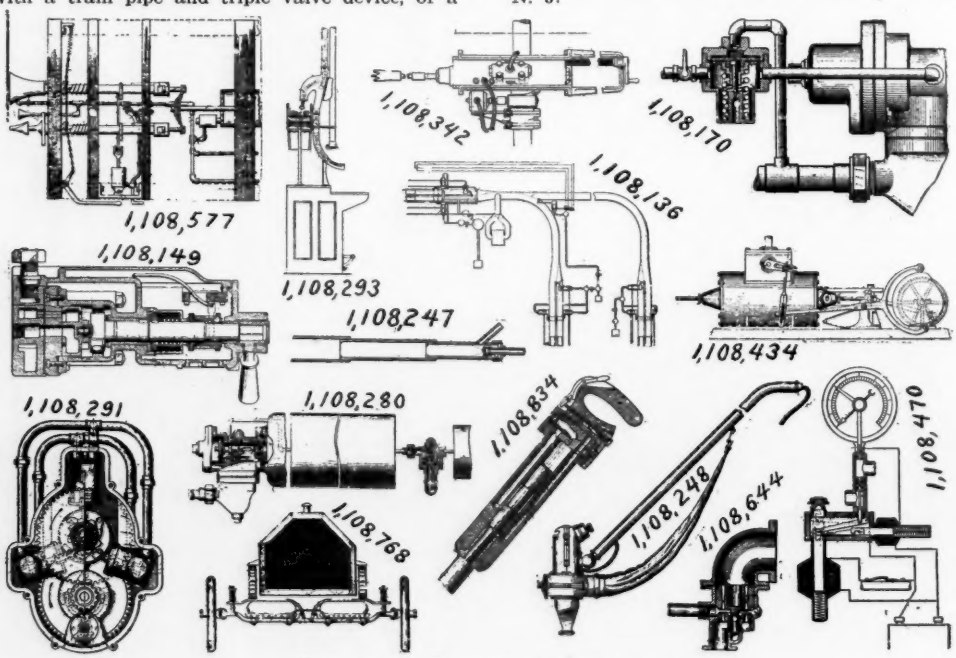
1,108,434. AIR COMPRESSOR OR PUMP. VENABLE J. GUTHRIE, Cambria, Va.

1,108,470. ELECTRIC PNEUMATIC - PRESSURE CONTROL. EDWARD K. PARKER, Santa Barbara, Cal.

1,108,577. AUTOMATIC CAR-COUPLING WITH AIR-OPERATED RELEASE. MATT HIMBERGER, Woodward, Iowa.

1,108,614. VACUUM-PRODUCING APPARATUS. FERDINAND A. WEIMANN, West Hoboken, N. J.

1,108,768. PNEUMATIC-CUSHION BOLSTER FOR VEHICLES. JOSEPH M. LEWIS, Trenton, N. J.



PNEUMATIC PATENTS AUGUST 25.

1,108,834. PNEUMATIC HAMMER. EMMETT G. DETRICK, Vicksburg, Miss.

1,106,264. ATTACHMENT FOR TOOLS. FRANK W. WHITE, Brooklyn, N. Y.

1,106,332. PERCUSSIVE DRILL. JOHN GEORGE LEYNER, Denver, Colo.

1. In a fluid operated drill, a drill cylinder and a piston therein having a drill rod projecting forwardly thereof, said drill rod having a fluid conveying bore, a front head on said drill cylinder, a fluid pump cylinder secured to the front head, a piston in said fluid pump having a rod secured to said drill rod, and fluid connection for conveying fluid from said pump to said drill rod bore.

1,106,346. PNEUMATIC - DESPATCH - TUBE APPARATUS. EDMOND A. FORDYCE, Boston, Mass.

1,106,349. VACUUM CLEANING AND HEATING SYSTEM. FRANK J. MATCHETTE and RICHARD RADDATZ, Milwaukee, Wis.